Project Completion report

April 1st, 2017

Project Title: Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry Land Areas

Grant Number 2000000172

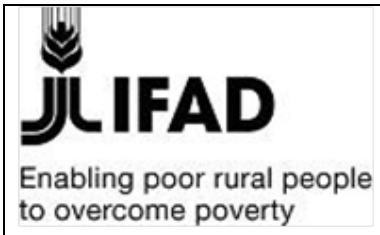
Reporting period March 13th, 2014 to March 12th, 2016

Submitted by

**International Centre for Agricultural Research in the Dry Areas (ICARDA)**

To

**The International Fund for Agricultural Development**




**Acknowledgement**

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**Disclaimer**

The authors accept full responsibility for the contents of this report. The report does not necessarily reflect the views of IFAD.

**Summary (*6Pages*)**

This technical report is a synthesis of activities undertaken between March 13th, 2014 and March 12th, 2016. Countries of engagement for this initiative were Egypt, Eritrea, Ethiopia, Kenya, Sudan and Yemen. As of March 12th, 2016, $539,471 of the allocated $1,470,000 remained underutilized, with over half of this amount relating to unspent staff costs for ICARDA social scientist engagement.

Prior to project closure, a request for no-cost extension was submitted by the International Centre for Agricultural Research in the Dry Areas (ICARDA) to IFAD. The argument for an extension at no-cost was based on delays in implementing activities at project inception, given a mutual decision between IFAD and ICARDA to first undertake a synthesis of an earlier phase of this initiative; and thereby identifying specific value chains for focus within this second phase.

Based on discussions over the week of March 6th, 2017, and considering the closure of the IFAD *AR4D Support for Dry Lands* in January 2017, ICARDA was advised that a no-cost extension could not be entertained.

Over the one-year period since the application for a no-cost extension, country partners have continued, and are continuing, to push forward on many activities initiated under this project – through their own volition and with their own (non-project) resources. A synthesis of this work, post March 6th 2016, is not captured within this report. As such, a proposal has been offered to hold a workshop cum write-shop over the week of May 13th, 2017 aimed at capturing learning, synthesize project lessons learned; and to document success stories, challenges and recommendations for efficacy in future undertakings. If accepted, a revision to this report will be submitted and one that is inclusive of learnings documented from the proposed workshop cum write-shop.

**Programme goals and objectives**

*Goal*: To enhance smallholder farmers' livelihoods in the Nile Valley and Sub-Saharan Africa Region through innovative research to business (R2B) platforms

*Objectives:*

a. Develop profitable and climate change-proof packages/models of tested and proven technology options;

b. Facilitate the institutional and policy environment for an accelerated scaling up of these technologies

**Programme components/outputs**

Objective (a):

i. Technology options or elements based on Nile Valley and Sub-Saharan African Regional Program (NVSSARP) and Yemen are consolidated and tested and subsequently validated through participatory stakeholder discussions;

ii. Economic profitability of the selected options through further analysis is confirmed;

iii. Simple farm level models relating to adoption of selected options with a range of stakeholders for better productivity and water use efficiency developed;

iv. Financial and economic viability of the consolidated and validated options conducted;

v. Enabling policy and institutional conditions, recommendations for effective transfer, and scaling-up of the technological packages options developed and conversed with decision makers;

vi. Business conditions needed for the sustainability of these options are identified;

Objective (b):

i. Analysis of the grass-root institutions, review of inventory and SWOT analysis conducted;

ii. Best organizational form for farmers to adopt commercial options: what is the social capital needed (resilience, binding elements, trust, leadership, governance structure) analyzed;

iii. Best bet matured elements for adoption of the models developed;

iv. Best capacity development strategies to attain maturity are implemented;

v. Analysis of the service delivery agencies in the private and public sectors (extension, seeds, machinery, input suppliers, markets, etc.) conducted;

vi. Identification of the best form of relationships and linkages between service providers to achieve economies of scale and ensure the sustainability of scaling up options developed;

vii. Regulatory and policy framework that affects the scaling up of the options: conducive or prohibitory, needs for improvement (for businesses, farmers, support services, extension, etc.) analyzed

**Key achievements against targets (output or outcome levels) under component/outputs as presented in the approved proposal (refer to the logframe). Summary of Progress from the previous report**

**Innovations (if applicable) and scaling up/adoption**

Activities undertaken within the ICARDA implemented initiative in each of the 6 countries were embedded within the framework of a research to business approach wherein technologies and production practices developed and tested for proof of concept in an earlier phase were taken to scale through inclusive and participatory innovation systems which involved public, private and civil society partners. This is different from a conventional (linear) process of technology transfer - from national and international research organization to public extension systems and onwards to farmers. Where existing IFAD development initiatives were being undertaken simultaneously within catchment areas for the initiative, collaboration was sought, and where possible fostered, in order to

leverage investments; and thereby to enhance broad uptake of demonstrated technologies (embodied as well as soft).

With the limited exception of Kenya, the project initiative was undertaken in countries where there has been a history of strong state led direction in agricultural production and planning, with limited engagement of civil society partners in the provision of rural advisory services. Where rural advisory services exist, outside of the domain of public extension services, they are generally limited to self-help groups, welfare societies and community based organizations. In this sense, the project initiative was tasked with a challenge of coalescing innovation systems which have historically been led by state led institutions, through state mandates and plans for agricultural production and marketing, and often void of market based incentives. They have also been undertaken in countries where public systems for agricultural extension have been facing significant constraints in financial and human resources, where insurrection and ethnic based violence have been on the rise; and in the cases of Ethiopia, Eritrea and Sudan, recurring bouts of famine. Understanding the process for enacting research for business approaches through mutually beneficial multi-stakeholder interactions and collaboration within these challenging environments is of value in sharpening conceptual and logical frameworks, as well as modalities for taking tested technologies and processes of innovation to scale.

Three significant lessons learned across all country initiatives are noteworthy, in so far as the notion of innovation as a process relating to (i) invention, (ii) adaptation/adoption, and (iii) sustainable shifts in conventional wisdom (including norms) which foster sustainability in creativity and capacity to innovate through an enabling policy and economic environment:

1. A previous project, related to this initiative and referred to as a 'first phase', was focused on the development of technologies (*embodied* in the form of seed; *soft* as in the form of a more effective production practice; or *organizational* as in the formation of groups, cooperatives or functional linkages between market actors). One aspect of the delay in undertaking project initiatives related to a decision by the steering committee (represented by both ICARDA and IFAD) to build on the technologies developed in the first phase, and to choose those specific technologies that were deemed to have a good chance for success in terms of scaling. In hindsight, and given that the first phase did not adequately concentrate on aspects of scaling within the research and developmental design and framework, this necessarily led to the *chosen technologies driving the process of scaling, as opposed to innovation systems defining the nature of technologies required to address systemic and systematic challenges within key value chains; and avenues for utilizing technologies as means towards a desired end. Technologies developed within the first phase were the object of scaling as opposed to instruments for achieving scale in the process for desirable developmental outcomes.* The

question of what is the object of scaling becomes important – technology or process?

2. Within national systems of innovation, conventional wisdom that technologies tested for proof of concept are immediately amenable to broad uptake by farmers continues to persist. In part, this relates to thin markets for agricultural inputs and agricultural advisory services within all of the countries engaged on this initiative, with the possible exception of Kenya. These in turn are shaped by paternalistic environments for agricultural production where state plans for key commodities, and high levels of subsidies in both production and consumption of agricultural commodities often distort incentives for private sector investment. "*Business oriented" approaches to scaling may not always be possible or suitable in environments where the state plays a significant role in directing agricultural production and marketing.*

3. The R2B approach was subject to confusion at the outset, and throughout the life of this short project initiative. In essence, the R2B approach aims to enhance broad uptake of tested technologies through an approach which maximizes value from the adoption of the technology. This necessarily requires an assessment of bottlenecks within value chains for commodities produced with the technology demonstrated and promoted, discovery of solutions to remedying these bottlenecks, and mutually beneficial economic relations between actors along the value chains. Gender equity should implicitly and explicitly be included within the framework of an R2B approach but was not well understood as noted in the section on gender below. In Sudan and Ethiopia, innovation platforms were set-up and this was presumably linked to experience from ongoing engagement between national partners and ICARDA on initiatives funded by the African Development Bank and related to a drive for national wheat self-sufficiency. On the surface, these platforms look very much like the R2B framework, but there are notable differences in so far as the state's role within the platforms. For future project interventions related to 'scaling', one recommendation is to articulate more specifically those interventions that are based on frameworks (eg. R2B), those that are process oriented in a specific place (eg. Innovation platforms) and those which are action oriented in terms of human interactions. *Frameworks and innovation platforms do not scale out technologies and processes; they facilitate interactions and modalities of interaction – innovation systems take technologies and processes to scale.* In connection with lesson 1, a heavy focus on technologies, as opposed to process and human interactions may have led to confusion on the pathway to 'scale' and a persistence to slip into a historical comfort zone of linear technology transfer mechanisms (research-extension-farmer). *Innovations systems are social systems in so far as they relate to interactions between human agents (individually or on behalf of an organization).* Future interventions aimed at 'scaling' and business centric models ought to ideally involve and incorporate social science perspectives in the early stages of project implementation. National partner nominations of

project staff have inherently been technical bio-physical scientists, thereby perpetuating more linear forms of technology transfer outlooks as opposed to systems thinking in processes for innovation.

These lessons learned should not be read with a view that this initiative was riddled with insurmountable challenges and therefore an inability to accomplish tangible outputs and outcomes. To be sure, the experiences attained and lessons learned are important outcomes on their own and valuable in their contribution to a contemporary global concern related to enhancing efficiency and efficacy within the process of agricultural innovation. In terms of tangible deliverables, a number of innovations were shown to be promising. These include:

1. Direct linkages between wheat producing farmers and flour millers that did not previously exist and which have improved farm gate incomes through both higher prices and farmer demand for improved seed varieties and agronomic (advisory) services which have reduced variability in production and stability in supply to market;

2. Better appreciation within national systems of research for the need to link technologies developed for improved forage production with those aimed at improved livestock rearing and breeding practices in order to enhance market returns (prices, volumes and quality of product shipped);

**Gender**

Notable outcomes related to gender have not been explicitly stated within this report. In part, this relates to a lack of understanding (or misunderstanding) on the part of national partners that participation of women in project activities does not necessarily translate into empowerment and nor into changes in social and cultural norms wherein equity and equality in access to resources often persist. A more detailed engagement on gender was highlighted by the steering committee in a meeting on November 25th, 2015 but with little opportunity for action given a fast approaching end of project timeline. One key lesson learned is that there is a need for greater knowledge and understanding of gender in agricultural development, and particularly so in relation to initiatives aimed at out scaling innovative processes and technologies where issues of equity in access to resources and equality in opportunity are concerned. This deficiency is not restricted to this project initiative, but inherent in a significant number of agricultural research for development undertakings globally, as evidenced by a growing concentration on the need for incorporating a gender lens into research and development programming at the outset.

**Partnerships**

National partners:

| | |
|---|---|
| Egypt: | Agricultural Research Centre (ARC) |
| Ethiopia: | Ethiopian Institute of Agricultural Research (EIAR) |
| Ethiopia: | Amhara Agricultural Research Institute (ARARI) |
| Eritrea: | National Agricultural Research Institute (NARI) |
| Kenya: | Kenya Agricultural and Livestock Research Organization (KALRO) |
| Sudan: | Agricultural Research Corporation (ARC) |

Yemen: Agricultural Research and Extension Authority (AREA)

(Notable) private, parastatal and civil society collaborators:
Tsehay farmer cooperative union (Ethiopia)
Amhara Seed Enterprise (Ethiopia)
Misr Al Kheir Foundation (Egypt)
Juhayna Food Enterprises (Egypt)
Red Sea General Mills (Eritrea)
Narok Livestock Traders Cooperative (Kenya)
Rupian Technologies Ltd. (Kenya)

**Conclusions (including priorities for next reporting period)**

Within the letter of request for a no-cost extension (March 8th, 2016), six activities were identified as not fully realized in terms of desired outputs and outcomes, given delays at the outset and compounded by seasonality in agricultural and livestock production cycles:

1. Scaling up the community-based goat breeding initiative to 400 goat keepers in Ethiopia (linked to objectives (a, b));

2. Scaling up the wheat package (improved varieties + agronomic practices) to 3 new villages in Eritrea, and strengthening agreements between farmers and flour millers in Asmara (linked to objective (a));

3. Installation of a village based wheat grain storage facility in Kenya, together with a roll out of approaches for more effective linkages between farmers and markets with desired outcomes for managing (price and loss of quality) risk (linked to objectives (a, b));

4. Installation of 30 additional pipe conveyance irrigation schemes in Sudan, and in collaboration with an existing IFAD development project which is providing farmer access to microfinance facilities (linked to objectives (a, b));

5. Linking farmers in 3 additional districts to the dairy processing unit established in the Asyut governorate of Egypt (linked to objective (a));

6. Documenting economic and gender related outcomes, at both commodity and household level, together with recommendations for enhancing sustainability of the approaches uncovered and tested within all countries engaged under this initiative (linked to objectives (a, b)).

Outcomes attained in the period following the official closure of the project on March 12, 2016 will be documented and lessons drawn, should the proposed workshop cum write-shop, for which a request has been made by ICARDA, materialize. This in addition to a main objective of the workshop to synthesize lessons learned in relation to targeting, innovation, learning and "scaling up". Knowledge gained would be of significant value to the global community of practice on innovation systems and agricultural research for development in terms of fine tuning methodologies and frameworks which are able to enhance efficiency and efficacy in agricultural innovation, and equity in the drive towards poverty alleviation.

**MAIN REPORT**: (20 *Pages excluding Annexes and Appendices*).

**Project Title:** Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry Land Areas

## I. BACKGROUND

### Project goals:

To enhance smallholder farmers' livelihoods in the Nile Valley and Sub-Saharan Africa Region through innovative research to business (R2B) platforms

### Project objectives:

a. Develop profitable and climate change-proof packages/models of tested and proven technology options;

b. Facilitate the institutional and policy environment for an accelerated scaling up of these technologies

### Project Components/Output:

Objective (a):

i. Technology options or elements based on Nile Valley and Sub-Saharan African Regional Program (NVSSARP) and Yemen are consolidated and tested and subsequently validated through participatory stakeholder discussions (COMPLETE);

ii. Economic profitability of the selected options through further analysis is confirmed (COMPLETE, BUT NOT FULLY DOCUMENTED IN SOME COUNTRIES AND WITH A NEED FOR STANDARDIZATION IN PRESENTATION);

iii. Simple farm level models relating to adoption of selected options with a range of stakeholders for better productivity and water use efficiency developed (NOT COMPLETE);

iv. Financial and economic viability of the consolidated and validated options conducted (CHALLENGES ENCOUNTERED);

v. Enabling policy and institutional conditions, recommendations for effective transfer, and scaling-up of the technological packages options developed and conversed with decision makers (NOT COMPLETE – LACK OF PROJECT LIFE);

vi. Business conditions needed for the sustainability of these options are identified (COMPLETE BUT NOT FULLY DOCUMENTED AT PROJECT END DATE);

Objective (b):

i. Analysis of the grass-root institutions, review of inventory and SWOT analysis conducted (COMPLETE);

ii. Best organizational form for farmers to adopt commercial options: what is the social capital needed (resilience, binding elements, trust, leadership, governance structure) analyzed (NOT COMPLETED);

iii. Best bet matured elements for adoption of the models developed (COMPLETE BUT NOT FULLY DOCUMENTED);

iv. Best capacity development strategies to attain maturity are implemented (LACK OF PROJECT LIFE TO FULLY CONTEMPLATE);

v. Analysis of the service delivery agencies in the private and public sectors (extension, seeds, machinery, input suppliers, markets, etc.) conducted (COMPLETE WITHIN THE FRAMEWORK OF ACTION RESEARCH);

vi. Identification of the best form of relationships and linkages between service providers to achieve economies of scale and ensure the sustainability of scaling up options developed (COMPLETE BUT NOT FULLY DOCUMENTED AT PROJECT END DATE);

vii. Regulatory and policy framework that affects the scaling up of the options: conducive or prohibitory, needs for improvement (for businesses, farmers, support services, extension, etc.) analyzed (COMPLETE, BUT IN NEED OF SYNTHESIS AND ARTICULATION WITHIN A SET OF BRIEFING NOTES)

## II. IMPLEMENTATION PROGRESS:

### A. Project expenditure by year

Financial reports, including audited statements, have been submitted separately. A summary of expenditures and receipts is as follows:

| Total Project Budget | Year: 1 | Year 2 | Total Expenditure |
|---|---|---|---|
| Funds received | 637,931 | 0 | 637,931 |
| Expenditure | 781,119 | 149,410 | 930,529 |
| Balance | (143,188) | (149,410) | (292,598) |

On March 12th, 2016, $539,471 of the allocated $1,470,000 remained underutilized.

### B. Brief comments on expenditure

A significant component of underutilized funds relates to "salaries and allowances" for ICARDA research staff (53%). In large part, this reflects the impact of a delayed start to project implementation, together with issues related to travel (visa acquisitions, instances of instability in country) that affected the ability for social scientists at ICARDA to fully and effectively engage on aspects related to: (i) economic analysis; (ii) gender; and (iii) functional innovation systems. These areas were scheduled for intensive engagement in the event of successful acquisition of a no-cost extension period together with technical backstopping of livestock scientists at ICARDA who had not been fully engaged, but required in terms of providing

recommendations for sustainability of initiatives undertaken and potential 'corrections' through technical backstopping of activities related to livestock feeding technologies and practices and more generally, animal health. The need for more intensive engagement of socio-economists was raised at the steering committee meeting held in Cairo on November 25th, 2015 but not fully enacted due to: (i) scheduling conflicts with end of year commitments on reporting, (ii) holiday leaves for staff (December-January), (iii) unexpected departure of the project coordinator (Marwan Owaygen) in January 2016; and (iv) delays in the transmission of a decision for a no-cost extension.

### C. Physical progress by component/output against targets

As noted in the section above.

### D. Progress by Components/Outputs realized since the submission of previous report

As this is a final technical report, progress has been reported for the full life of the project. Where relevant, mention is made on actions taken to address comments made on previous reports or recommendations made by the project steering committee.

### E. Difficulties encountered and measures taken to resolve problems

In January of 2016, the coordinator for this initiative stepped down from his position at ICARDA, leaving a vacuum at a critical period of the initiative, given three months to closure. A caretaker role was assumed by ICARDA's social scientist, based in Cairo, and one who would lead the workshop proposed for May 2017, if granted; as well as the development of knowledge material stemming from this engagement.

## *III.* INNOVATIONS

Technical innovations:

1. Efficient (maize) silage production aimed at reducing post-harvest waste, reduction in environmental pollution (burning of waste), and aimed at improving livestock productivity in milk production (Egypt);

2. Cultivation of Berseem Clover as a mono-cut forage crop to be planted after summer harvesting of corn and prior to the planting of winter wheat in order to improve milk productivity (Egypt);

3. Improved chickpea and vetch varietal introduction and demonstration to reduce the off season livestock feed gap and enhanced returns to goat rearing operations (Ethiopia);

4. Improved fattening and rearing practices to support greater returns within local markets (Yemen, Kenya);

5. Improving returns to wheat and vegetable crops (onions and tomatoes) through higher productivity and linkages to markets

Organizational innovations:

1. Village based milk collection and processing, with attention to hygiene and price premiums relative to local milk collector prices (Egypt)
2. Improving wheat productivity and linking farmers to flour mills for guaranteed prices (Eritrea, Kenya)
3. Community based goat breeding programmes - building on existing interventions nationally (Ethiopia)
4. Auctions for live animal sales, tied to dissemination of improved sheep fattening practices (Kenya)
5. Facilitating technical and economic (microcredit) support in the development of piped irrigation infrastructure and linked to parallel IFAD supported initiatives within the catchment area (Sudan)

## II. GENDER ISSUES

Notable outcomes related to gender have not been explicitly stated within this report. In part, this relates to a lack of understanding (or misunderstanding) on the part of national partners that participation of women in project activities does not necessarily translate into empowerment and nor into changes in social and cultural norms wherein equity and equality in access to resources often persist. A more detailed engagement on gender was highlighted by the steering committee in a meeting on November 25th, 2015 but with little opportunity for action given a fast approaching end of project timeline. One key lesson learned is that there is a need for greater knowledge and understanding of gender in agricultural development, and particularly so in relation to initiatives aimed at out scaling innovative processes and technologies where issues of equity in access to resources and equality in opportunity are concerned.

## III. Nutrition (*if applicable*)

**n/a**

## IV. PARTNERSHIPS

National partners:

Egypt: Agricultural Research Centre (ARC)
Ethiopia: Ethiopian Institute of Agricultural Research (EIAR)
Ethiopia: Amhara Agricultural Research Institute (ARARI)
Eritrea: National Agricultural Research Institute (NARI)
Kenya: Kenya Agricultural and Livestock Research Organization (KALRO)
Sudan: Agricultural Research Corporation (ARC)
Yemen: Agricultural Research and Extension Authority (AREA)

(Notable) private, parastatal and civil society collaborators:
Tsehay farmer cooperative union (Ethiopia)
Amhara Seed Enterprise (Ethiopia)
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Juhayna Food Enterprises (Egypt)
Red Sea General Mills (Eritrea)
Narok Livestock Traders Cooperative (Kenya)
Rupian Technologies Ltd. (Kenya)

## V. KM Products

As noted within the summary, these products have not been fully realized in light of delays in the completion of key project activities. A proposal for a knowledge centred workshop cum write-shop in the middle of May 2017 would yield a number of products aimed at showcasing project successes, as well as products aimed at informing the global agricultural research and development communities on lessons learned in terms of "scaling up".

## VI. CONCLUSIONS

A synthesis of lessons learned has been provided within the introductory "Summary" section. Individual country reports are presented in the following section. Each have been presented in a different style, and amenable to the nature of interventions undertaken and the contextual nature of the interventions undertaken.

All country partners have highlighted the need for further development of the initiatives undertaken within this initiative, in terms of a better articulation of a R2B framework within their contextual environments; and in terms of learnings attained from global experiences within the larger thematic area of agricultural innovation systems. This is a significant outcome, in so far as it relates to a potential shift in conventional wisdom, as well as in the potential for shifts in how research is conceptualized and undertaken within national centres of agricultural research.

One clear lesson learned is that 'scaling' takes significant time and facilitation. A two-year initiative is simply not sufficient to ensure sustainability in process and particularly so given agricultural seasons and the vagaries of weather and drought in dryland areas. Equally important is the need to incorporate issues of scaling into project interventions at an earlier phase, as opposed to staging the many processes within a system of innovation: invention, adaptation/adoption and enabling policy and economic environment. These processes should not be seen as additive, but rather as cyclical and reinforcing process within a system that incorporates both technical dimensions and social (human interaction) dimensions, with trade-offs that are inherent and which need to be understood and negotiated.

# EGYPT FINAL TECHNICAL REPORT

*Integrated Agricultural Production Systems*
*For the Poor and Vulnerable in Dry Areas*

***Grant Title:***

**Improving smallholder farmer livelihoods in the Nile Valley and Sub-Saharan Africa Region through transforming research outcome to create commercial opportunities**

***Duration :*** 2 Years (March 13, 2014 – February 12,2016)

# *Progress Report – Egypt*

**May 2016**

## ***Background:***

The first phase of this project was titled “Improving the livelihoods of Rural Communities in the Dry Areas: Sustainable Crop and Livestock Management” . The project started September 2010 and terminated in September 2013 (three- year duration). The project aimed at increasing agricultural production , improving farm household income and using the integrated natural resources management and community-based participatory approach to enhance food security, livelihood and adaptive capacity of resource poor farmers to cope with climate changes and vulnarability. Six districts were selected in Assiut governorate , and tewenty farmers in each district were nominated to participate in the project. Assiut governorate was selected due to several factors: (1) cultivated area for each family is very limited, (2) low income and low crop production which due to several bio-physical and economic factors as follow:

(a) Poor soil fertility as a result of poor management.
(b) Limited use of fertilizers .
(c) Wide spread of agricultural pests as aphids in wheat and faba bean
(d) Infestation with of specific weeds as wild oats in wheat and other winter crops.
(e) Lack of implementation of recommended technological packages and limited access to extension services.
(f) Non-availability of high quality seeds.
(g) Poor water and crop management for sustainable agriculture .
(h) Lack of technical knowledge in livestock management and little harvest of milk.

The project in phase I supported farmers with new crop cultivars characterized by tolerance to heat stress, high yield potential and resistance to crop diseases.

The project also introduced new crops to the farmers to increase their incomes and applied different crop intensification methods to increase profits out of the same owned area. The project applied research outcomes on farmers' fields including recommended cultivars and hybrids, agricultural technological package, water management and recommended animal husbandry methodology. The main achievements of project phase I activities can be summarized as follow:

1- Increase crop production of field and vegetable crops as a result of planting new adapted cultivars and applying the recommended technological packages .
2- Disseminate planting crops on raised beds which resulted in higher grain yield by about 20% , saving about 25% of irrigation water, decreasing fuel amounts required for irrigation pumps operation and increasing nitrogen use efficiency .
3- Crop intensification increased agriculture production per unit area leading to higher income.
4- Making silage from corn and sorghum stalks after harvesting ears increased farmers' income, availability of animal forage in summer with higher nutrition value and saved environment from burning corn and sorghum residues.
5- Wheat straw treatment with urea increased protein content from zero to 8% to increase straw nutritive value for animal feed.
6- Improve livestock management by introducing new formula of animal feed, better management in animal housing , animal health care and other management methodology had resulted in increasing animal weight and milk harvest. In addition, the project supported farmers with a new breed of sheep "Alfrafra" which is tolerant to heat stress and females produce twins when crossed with Alfrafra rams .

7- Capacity building for farmers and extension staff through training courses in crop and animal production.

These activities led to improving farmers' income, reducing costs of farming system, improving soil characteristics for sustainable agriculture, increasing farmers' knowledge through training courses and field visits. These gains improved smallholder farmers livelihoods using the integrated natural resources management to enhance food security for poor farmers .

## ***Lessons learned from phase I:***

1- High impact of planting leguminous crops on soil fertility and agricultural sustainability.
2- Multidisplinary approach resulted in better improvement in plant and animal production .
3- Links between farmers and private sector to provide their needs of seed, fertilizer, pesticides and animal feed.
4- Importance of training and field visits to accelerate adoption of new technological packages.
5- Crop intensification is a good approach to increase crop production and consequently farmers' income.
6- More efforts are needed to improve productively of small animals as sheep and goats.
7- Post harvest treatments to utilize crop residues as fodder as making silage from corn stalks and treating wheat straw with urea to raise its nutritional value.

## ***Project Phase II:***

The title of the project is “Improving smallholder farmer livelihoods in the Nile valley and Sub-Saharan Africa region through transforming research outcomes to create commercial opportunities”.

The overall goal is to enhance smallholder farmers' livelihoods through innovative research to business (R2B) platform.

The main objectives of the project can be summarized as follow:

1- Merge the research and development demands to alleviate poverty.
2- Improve water productivity .
3- Capacity improvement of farmers especially gender through demonstrations of research outputs .

The overall goal and the main objectives are complementary to those in phase I. The project in phase II will link research outcomes to business enterprises involved in technology transfer . Moreover , the project will have linkages with IFAD projects in the region and will cooperate for complementary application and experience exchange, the two IFAD projects working in Upper Egypt are:

1- On – farm Irrigation Development Project in the Old Lands (OFIDO 2010-2018).
2- Promotion of Rural Incomes through Market Enhancement Project (2012-2020).

Therefore, the project committee selected El- hammam village in Abnob district and Arab Motair in El-Fath district for the activities of the project . Visits to the two sites revealed that the main activity of small holder farmers is a mixed farming system including planting field crops and animal production . The main crop in summer is corn while wheat and clover (berseem) are the main crops in winter. Farmers in the two villages suffer from lack of forages in summer in addition to low milk harvest of their livestock . Therefore, the project activities in phase II included making silage from corn stalks which was demonstrated in phase I, helping farmers in silage marketing , developing

animal production , providing farmers with new forage crops through crop intensification to increase their income without reducing crop production of their field crops. In addition, farmers have many constraints in milk marketing where traders from other villages buy the milk with low prices and sometimes leave the milk for farmers which causes big losses and they have to give the milk for free to their neighbors. Therefore, the project activities included helping farmers in marketing milk production in addition to improving animal production which will be introduced in animal production component in this document.

## ***I . Achievements of Crop Production:***

### ***A. Making Silage:***

The project demonstrated making silage from corn stalks after harvesting corn ears. Demonstration included making silage for ten farmers in each village. Many farmers adopted this procedure to have forage for their animals at the time of lack of forages and to save their environment from burning corn stalks . However, farmers made big amounts of silage and there is no marketing for it. Therefore, the project contacted Misr El-khair farm for animal production in Assiut where they use big amounts of corn silage in feeding cows. A meeting between Misr El-khair administration, farmers from the two village and the project coordination committee was held in Assiut. Misr El-khair technician explained the conditions of corn silage and how to apply the agricultural practices for good quality silage. Discussions included planting area, amounts which must be delivered within specific time and other conditions. The farmers found many constraints to plant corn for making silage according to Misr El-khair conditions. However , the main limiting factor was the price per ton offered by Misr El-khair (MK) which was very low. Hence, farmers refused to produce corn silage for MK. However, the project tried to raise the price and support farmers with corn seeds but Misr El-khair refused to receive corn silage from the farmers and refused to raise

the price. Farmers decided to make silage for their needs only and market excess silage within their villages if possible.

## B. Crop Intensification and Planting Fahl Berseem:

Because animal production in the two villages of the project represents an important part for farmers' income and there is lack of fodder and forages to feed livestocks, therefore , the project introduced fahl berseem a mono-cut forage crop to be planted after harvesting corn and before planting wheat. The main target of introducing fahl berseem is to increase farmers' income through crop intensification instead of leaving the farm fallow between summer and winter seasons, planting leguminous crop (berseem) between two graminea crops (maize and wheat)will help in fertility build up of the soil for sustainable agriculture and consequently increasing crop production. Moreover, fahl berseem has a better nutritional quality than wheat and maize straw and corn silage . Farmers are used to feed their animals on wheat and corn straw and they used corn silage after the project started its activities. Fahl berseem was planted last season (2014/2015) and farmers used it in feeding their animals and noticed the better performance of the animals and the increase in milk harvest . Chemical analyses of fahl clover, maize straw and silage are presented in Table (1)

Table (1) Total nitrogen and protein percentages of fahl clover, maize straw and maize silage .

| No | Sample | Total nitrogen % | Protein % |
|---|---|---|---|
| 1 | Fahl clover | 2.85 | 17.82 |
| 2 | Maize silage | 1.51 | 9.45 |
| 3 | Maize straw | 0.58 | 3.65 |

Date presented in Table (1) show that fahl berseem has the highest protein percentage (17.82%) while maize straw contains 3.65% , maize silage provide 9.45% protein . Farmers gained more milk after feeding their animals on Fahl berseem which contains protein about five folds that in maize straw and almost double that in maize silage . Planting Fahl berseem added about 3000 L.E. to farmers income in about 75 days and increased soil fertility after cutting berseem . Table (2) shows soil analysis of total nitrogen after harvesting maize and berseem . Data revealed higher nitrogen percentage in the soil after cutting berseem. This type of crop intensification resulted in higher wheat grain yield after cutting berseem than planting wheat after harvesting corn (the tradition procedure by farmers). The project provided ten farmers in each village with berseem seeds and results are shown in Table (3). The Data show that farmers gained more than what is equivalent to 40 ton/ha of fodder with added value more than 3000 L.E.

**Table (2): Soil analysis of total nitrogen in soil samples after harvesting corn and after cutting berseem .**

| No. | Soil Sample | Total Nitrogen % |
|---|---|---|
| 1 | After harvesting corn | 0.163 |
| 2 | After cutting berseem | 0.171 |

**Table (3): Average fodder yield of Fahl berseem in twenty fields in El-Hammam and Arab Motair villages.**

| No | El-Hammam | Arab Motair |
|---|---|---|
| | Yield (ton/ha) | Yield (ton/ha) |
| 1 | 44.5 | 39.2 |
| 2 | 44.1 | 41.8 |
| 3 | 43.8 | 44.0 |
| 4 | 45.4 | 34.1 |
| 5 | 43.2 | 37.1 |
| 6 | 43.2 | 39.0 |
| 7 | 36.6 | 42.6 |
| 8 | 34.1 | 33.5 |
| 9 | 33.6 | 33.9 |
| 10 | 34.0 | 35.0 |
| **Mean** | **40.3** | **38.0** |
| **General Mean** | **39.2** | |

**Table (4) Average grain yield (ton/ha) of wheat planted after harvesting corn and after cutting Fahl berseem.**

| No | El-Hammam | | Arab Motair | |
|---|---|---|---|---|
| | **After corn (ton/ha)** | **After berseem (ton/ha)** | **After corn (ton/ha)** | **After berseem (ton/ha)** |
| 1 | 8.46 | 9.32 | 8.46 | 9.18 |
| 2 | 7.92 | 9.47 | 7.99 | 8.68 |
| 3 | 7.83 | 9.44 | 7.20 | 8.37 |
| 4 | 7.63 | 8.42 | 7.67 | 9.01 |
| 5 | 7.56 | 9.45 | 7.38 | 8.24 |
| 6 | 7.96 | 10.08 | 8.28 | 9.00 |
| 7 | 7.96 | 8.87 | 7.92 | 8.73 |
| 8 | 7.92 | 8.71 | 7.38 | 8.06 |
| 9 | 9.00 | 9.81 | 8.91 | 9.65 |
| 10 | 7.70 | 9.25 | 8.03 | 9.31 |
| **Mean** | **7.98** | **9.28** | **7.85** | **8.86 (13%)** |

The project provided 20 farmers in the two villages (ten in each village) with wheat seeds to be planted after cutting berseem to be compared with that planted after harvesting corn . The project planted wheat on raised beds to demonstrate and disseminate that technology to farmers. Grain yield of wheat was evaluated under the two conditions (after corn and after fahl berseem). Table (4) shows wheat grain yield in the two villages, data revealed the superiority of grain yield of wheat planted after cutting Fahl berseem over that harvested after corn . Average grain yield in El-Hammam was 9.28 ton/ha after barseem vs. 7.98 ton/ha after corn (16.22 % increase) and 8.86 ton/ha after berseem vs. 7.58 ton/ha after corn in Arab Motair (12.84 % increase). These findings confirm increasing farmers' income through planting Fahl berseem (added value) and increases in wheat grain yield .

## C. Out- puts and Out –comes of Crop Production Component:

## 1- Making silage:

## C.1. Making silage

Farmers were used to harvest corn ears and cut the stalks then pile them at the sides of irrigation canals, drainages, or at the two sides of the roads. Corn residues created many problems for the farmer and became a source of rodents , snakes and other pests. Therefore, farmers used to burn corn residues which is harmful to the environment (air and soil pollution).Making silage had good effects on the environment and provided farmers with feed for their livestock at the end of summer season where there is no green forages available for the animals. Silage contains higher Protein percentage than corn stalks (9.45 vs. 3.65) as shown in table (1) which resulted in better performance of the livestock and higher milk harvest leading to higher income for the farmers. Farmers gained about 30.6 tons of silage per ha for feeding animals ; extra silage over their needs was a source of about 1000-2000 EGP. The practical training on making silage from corn stalks raised the ability of participants and their neighbors on making silage and increasing their income while reducing air pollution and keeping relatively cleaner environment. .

## C.2. Crop intensification:

Farmers were used to plant corn in summer and wheat in winter. Corn being harvested in September and wheat planted in November then farmers were used to leave their fields fallow during September and October until mid-November. The project introduced fahl berseem seeds to farmers and held training courses for planting berseem after harvesting corn and before planting wheat . This type of crop intensification increased farmers income by 3000 EGP in 75 days (berseem duration in the soil). In addition, berseem has higher protein percentage than corn silage and corn straw (17.82 vs . 9.45 and 3.65% respectively) as shown in table (1) . Availability of berseem at that time led to higher milk harvest from livestock and better performance of the animals.

Moreover, planting berseem between two cereal crops (corn and wheat) improved soil characteristics and helped in building up soil fertility as a leguminous crop which resulted in ling her wheat production by about 3-2 ardab/fed (average increase of the two villages as shown in table 4). Increases in wheat grain yield increased farmers' income by 1344 EGP per faddan .

**C.3. Planting wheat on raised beds:**

One of the good out-comes of the project in phase I and II is training farmers on planting wheat on raised beds which resulted in:

1. Saving of 30 to50 kg of seeds used in planting .
2. Saving more than 20% of irrigation water and increased fertilizer use efficiency.
3. Reducing amount of fuel for irrigation water.
4. Decrease in time of irrigation which reduceds labor costs.
5. Planting on raised beds reduceds opportunities for wheat plants lodging saving more crop for farmers.
6. Results of planting wheat on raised beds indicated that wheat productivity had increased by about 20% that the traditional method.

## II. Livestock Management Component

## Outline for phase I of the project (2011 – 2014)

Project site: Assiut Governorate (Egypt) including six districts

Appraisal of Animal Production Component

- Participating farmers in the project were visited to recognize animal production activities (2011) .
- Initial information were collected from 14 farmers about pattern of animal feeding, animal housing, raising young animals, fertility management and prevention against common diseases.
- Data collection using questionnaire were analyzed for economic appraisal of animal productivity

### Statistical and descriptive findings of the collected data:

Table (5) display the holding capacity and production purpose among the targeted farmers whereas, table (8) show percentages of constraints facing improvement of animal productivity as assigned by farmers.

### Managerial aspects of animal breeding:

- Winter and summer feeding depends on a mixture of wheat bran and mesh yellow corn in addition to fresh clover (*Trifolium alexanderinum)* and maize stalks or wheat straw when available.
- Prolonged calving interval and low fertility rate
- Daily milk yield of native cattle 5-6 kg ( 4 LE /kg ), Daily milk yield of buffaloes 6-8 kg ( 5 LE /kg )
- Artificial insemination (AI) service is not available in many districts.

**Constraints of animal productivity (Observations):**

- Absence of knowledge about animal husbandry
- Lack of training programs on animal production aspects for extension staff.
- Malnutrition of animals particularly at small holders level due to improper feeding pattern
- Lack of hygienic considerations in structure and space concomitant in Animal housing
- Poor veterinary services and AI services
- Instability of animal holding or targeted production purpose due to socio-economics.

**Table (5) Holding capacity and production purpose among targeted farmers**

| | | Holding capacity and production purpose | | | |
|---|---|---|---|---|---|
| Categories | Breeds | Small holder | Production purpose | Medium holder | Production purpose |
| Cows or Buffaloes | Crossbred or Local | 1-3 | Milk for home consumption | 5-9 | Milk marketing |
| **Heifers** | **Crossbred or Local** | **0-1** | **Replacement** | **2-4** | **Replacement** |
| **Off-springs** | **Crossbred or Local** | **1-2** | **Raising** | **2-5** | **Replacement** |
| **Sheep or goats** | **Local** | **3-5** | **Fattening** | **8-12** | **Replacement + Fattening** |
| **Lambs or kids** | **Local** | **1-3** | **Raising** | **4-8** | **Raising** |

## Suggested innovation packages:

**1-** Upgrading animal productivity of animal holders by improving skills and providing technical material.

2- Setting up training courses on livestock management for both animal holders and extension staff.

3- Adoption of demonstration packages to improve animal productivity (silage making, ration formulation, early weaning & fattening of calves and modification of animal housing).

4- Genetic improvement of animal productivity by crossing native cattle, sheep and goats with purebred

5- Improving animal health across collaboration with veterinary units.

Three main steps were considered for innovation: (Training – Demonstration – Farm monitoring)

Project activities implemented for animal production improvement during phase I :

- **Technical training**:

The first training course on animal husbandry in phase I (May 2011)

- Six days training course (7 hours per day) was arranged on animal husbandry at Sakha training unit belonging to Animal Production Research Institute, Kafr El- Sheikh Governorate (May 2011)
- The course was attended by 11 farmers (participating in the project ) besides 11 extension men.
- The course covered all subjects pertinent to animal husbandry such as reproductive disorders in dairy animals, raising and growing calves, management of pregnant and milking cows, principles of animal nutrition, raising sheep and goats…….etc.
- Implementation of extension packages and demonstrative activities.
- Extension materials was distributed among the animal holders to showits importance in improving animal productivity.

The second training course on animal husbandry in phase I (April 2013)

- 12 nominees were belonging to the regional project countries, i.e. Egypt, Sudan, Ethiopia and Yemen

The training course was implemented at The International Livestock Management Training Center - ILMTC (Sakha), Animal Production Research Institute (APRI). The course was 70 hours training period (7 hours per day) including lectures and field training at Sakha experimental farm.

New concepts were considered in the plan of this course :

- The training course focused on subjects that are closely related to the social and environmental conditions in regions of the trainees.
- Range managements, Optimum utilization of field by- products,
- Alleviation of heat stress among animals and making improved dairy products
- Lectures and practical training were presented in both English and Arabic languages

## Demonstrative activities:

Extension packages for project participants is presented in table (9)

**Farm monitoring visits:**

- Monitoring visits were performed on biweekly basis to follow up:
- Utilization of corn stalks silos performed on October 2011
- Revealing obstacles of animal raising and farm management.
- Detect the impact of dispatched extension materials for improving animal productivity.
- Updating the farmer knowledge concerning animal husbandry.
- Improving animal feeding during summer, utilization of farm by-products in animal feeding and conservation of green forages.
- Suggesting methods to alleviate animal heat stress during summer
- Improving animal housing by shading,

- Short term cooling of cattle by water, increasing daily water consumption, supplement of buffers to justify rumen pH, feeding animals on succulent forages.
- Udder care and mastitis control during summer was discussed.
- Extension booklets were given to farmers.

**Table (6) Impact of training, innovative packages and monitoring visits (Phase I)**

| Means of Verification | Impact | Remarks |
|---|---|---|
| **Mortality rate of young animals** | **Nill** | |
| **Affection by Infectious diseases** | **Nill** | **FMD was spreading on 2012** |
| **Control of parasites** | **Relative improvement** | **Mass treatment is required** |
| **Crossing local sheep with Frafra ram** | **11 cross lambs** born | **Ewes of neighbors were also crossed** |
| **Culling improper producing animal** | **4 cows replaced** | |
| **Interest for genetic improvement** | **Arrangement to purchase Truntees cattle (APRI)** | |
| **Use of supplemental protein (Concentrate)** | **Positive detection for fattening** | **High cost of concentrate hinder continuous use** |
| **Control of mastitis** | **Only one case** | **Focus on subclinical cases** |
| **Rely on subsidy** | **Negative impact** | **Encourage Banking loans** |
| **Housing system improved** | **Relative improve** | **High cost of required material** |
| **Tendency for single production purpose** | **Relative** | |
| **Marketing of products** | **Impediments for small holders (Co-operatives)** | |

**Project Second Phase Outline (2014 – 2016)**

**Project site: Assiut Governorate (Egypt) including two villages:**

**El-Hamam (Abnob District) and Arab Mtair (El-Fath District)**

Since positive impacts of technical innovations were detected among phase I participating farmers when compared and with neighbor farmer. It was interesting to transfer from research oriented activity into marketing oriented disciplines. Therefore, some ideas were suggested for promotion of marketing products.

In the second phase of the project, it was decided to focus efforts toward upgrading skills of large number of farmers in two villages within two districts (i.e Abnob and El-Fath). Both districts are subjected to developmental support implemented by IFAD. Twenty new farmers in each district were chosen to participate in the project activities. Since both districts were involved in disciplines of the first phase, similar managerial aspects of animal breeding and constraints of animal productivity were observed (Table 7 and Table 8).

## Activities and achievements of phase II:

1. The third training course on animal husbandry was performed in February 2015 at Sakha training unit. Eighteen farmers and two extensionists attended this course. Program of training was similar to that of May 2011 .
2. On farm monitoring (animal husbandry, ration formulation and introduce further extension materials)
3. Silage making during summer and winter using different by-products.
4. Intensive care of rams during the transition period.
5. Enhancement of veterinary services and mass treatment.
6. Making hay from the excessive Egyptian clover (*Trifolium alexanderinum*) for animal summer consumption.
7. Alleviation of summer heat stress among different species of animals.

8. Giving interest for sheep breeding as a rapid source of income and efficient consumer of farm byproducts.
9. Continuous crossbreeding of local sheep with Frafra breed to upgrade fecundity of females.
10. Cultivation of Barseem Fahl (single cut) to increase forage production before wheat cultivation.

**Table (7) Land and animal holding in the project area (Phase II).**

| **District** | **Abnob** | **El-Fath** | **Total** | **Remarks** |
|---|---|---|---|---|
| **Villages** | **EL-Hammam** | **Arab motair** | | |
| **No. Farmers** | 16 | 15 | 31 | |
| **LAND TENURE** | 1.73 F | 1.53 F | 1.63 Average | |
| **Mature Cows** | 30 | 20 | 50 | **Small Holding** |
| **Young Stock** | 33 | 16 | 49 | **16 M and 19 F** |
| **Total** | 63 | 36 | 99 | |
| **Pregnancy %** | 66.7 | 65 | | |
| **Mature Buffalo** | 6 | 12 | 18 | **Limited** |
| **Young Stock** | 3 | 1 | 4 | **1 M and 3 F** |
| **Total** | 9 | 13 | 22 | |
| **Pregnancy %** | 83.3 | 100 | | |
| **Sheep** | 24 | 34 | 58 | **Higher interest** |
| **Goat** | 17 | 19 | 36 | |

**Table (8) Percentages of farmers facing constraints of animal productivity improvement as assigned by farmers (1st and 2nd phases of the project)**

| Constraints | Percent of farmers complained | |
|---|---|---|
| | Phase I | Phase II |
| Lack of fodders | 8 | 14 |
| High prices of concentrates | 35 | 42 |
| High prices of vet. medicines | 10 | 12 |
| Lack of veterinary service | 17 | 20 |
| Poor milk marketing channels | 9 | 15 |
| Poor animal marketing channels | 7 | 8 |
| Inability to purchase good breeds | 15 | 12 |
| Lack of artificial insemenation | 8 | 20 |

**Table (9) Distribution of extension packages for project participants of phases and 2of the project**

| Extension packages | Demo application | No. Beneficiaries | | Project Subsidy % |
|---|---|---|---|---|
| | | Phase I | Phase II | |
| Genetic improvement<br>Frafra rams for crossbreeding sheep | Individual | 5 | 21 | 25 |
| Utilization of field by products<br>Silage making | Group | 3 | 20 | 50 |
| Raising nutritive value<br>Wheat straws treatment with urea | Group | 14 | 10 | 100 |
| (Concentrates 44% CP)<br>Soybean cake | Individual | 10 | 24 | 50 |
| Intercropping<br>Fodder beat cultivation | Individual | 4 | ----- | 100 |
| Mufeed blocks (Supplemental feed) | Individual | 14 | ----- | 100 |
| Mineral deficiency treatment<br>Mineral blocks | Individual | 12 | 30 | 75 |
| Hoof nipper (Hoof care) | Individual | 9 | ----- | 100 |

**Promotion of Marketing products:**

Available Opportunities for marketing milk were monitored and evaluated and different alternatives were studied . The following options were on the table.

A. Juhyna milk company in Assiut could receive big amounts of cow milk and the factory is near by the two target villages .

B. Mmilk traders and cheese making factories in Assiut could use the two villages milk.

C. Establishing milk collection unit in one of the two villages and training the farmer on processing milk products.

The project team worked very hard on the three options but efforts succeeded in establishing milk collection unit in Arab- Motair village (the third option) and the constraints of the two firstoptions can be summarized as follow:

**A. Juhyna milk Company:**

The project team visited Juhyna company in Assiut and explained the mission of the project and than it is mainly a development project to help poor farmers in marketing the milk production because they loose big money when they sell it to the small traders on the villages. However, Juhyna team apologized for not receiving farmers milk production for the following seasons :

1- Juhyna contract big farms only not small farmers as they receive big amounts of cow milk only for continuous work of the factory.
2- The milk must be harvested mechanically while farmers harvest milk by hands.
3- Received milk must meet their conditions for processing yogurt including pH value, acidity, bacterial count (the most important parameter) and other conditions. Produced milk by farmers could not meet these conditions especially bacterial count as that factory is specially for making yogurt.

**B. Milk traders in Assuit:**

The project team looked for the seconed option and visited about six markets deal with milk and its products as cheese and yogurt. All two-month efforts failed to contract farmers with any factory because they receive buffalo milk only while the main problem of the farmers is marketing cow milk and they do not have the transportation mean to deliver milk to traders in Assuit.

**C. Establishing milk collection unit:**

General discussion between the nominated owner of the village collection unit and village cooperative director included the following points:

1- The main purpose to establish the village milk collection unit (VMCU) as assigned by the project and conditions needed to collaborate between village cooperative (VC) and the owner of the milk collection unit (OMCU).

2- Official transfer of equipments and tools of VMCU (purchased by the project) from VC to OMCU.

In consequence, OMCU should be regularly keen to conserve and maintain the equipments and tools. Also, board of VC might have the responsibility of equipments and tools.

3- It is conditional that milk collection goes from farmers to the collection unit without intermediate traders.

4- Sanitary and industrial security rules should be considered**.**

5**-** The OMCU must receive and purchase all cow and beffulo milk from the farmers of the two villages and neighboring with higher price than paid by traders.

6- The OMCU must have the transportation means to collect milk from the farmers.

Four farmers were nominated to prepare the collection unit but only one responded positively and prepared the unit according to the technical conditions assigned by the project .

**The essential purchased items needed for the milk collection unit (MCU) are as follow:**

| Items | Units required |
|---|---|
| **Milk cooling tank (Stainless steel one ton capacity)** | **1** |
| **Milk cooling tank (Stainless steel 0.5 ton capacity)** | **1** |
| **Milk separator** | **1** |
| **Butter churner** | **1** |
| **Milk collection buckets 50-60 kg** | **10** |
| **Centerifuge unit** | **1** |
| **Measuring and testing tools** | **group** |
| **Cheese making vat (200 kg capacity)** | **1** |
| **Refregirater** | **1** |
| **Electric generator (4 k watt)** | **1** |

The project purchased the needed items and provided them to the owner and helped him technically in fixing these items , both the project team and co-op team attended the establishment of the milk unit. Before starting the work and receiving the milk, four farmers (the owner and three assistances) attended a training course on milk preservation and processing in the Dairy Department, Agriculture Colloge, Assiut University for ten days. Official opening was held for the unit on 24/11/2015 in the presence of the official leaders of agriculture in Assiut governorate, working team of the project . co-op team, ICARDA regional coordinator, national coordinators of participating countries in the region and Deputy Director of ICARDA (Dr. Kamel Shedid)

The project tean monitored up the activities of the VMCU and the owner purchased milk from farmers with higher price than that paid by the traders . and purchased a small truck to collect the milk from farms, He also processed

cheese , yogurt, butter and ghee and started to sell his products in the surrounding villages and Assiut.

The activities were extended to iclude training for other farmers in Assiut governorate. A training course was held every week for farmers and extensionists from other project non-participating districts of Assuit governorate. The project provided transportation for about 20 trainees each time and training took place in one of Assiut University conference rooms then trainees were transferred to the VMCU in Arab Motair to get practical training by the owner and his assistants. Training included equipment management, milk preservation, making cheese and yogurt, separating fats, ….. etc. The training was on Jan. 12 Jan 26 and February 9,2016. However, ICARDA fund was stopped and activities stopped after that.

**Out-comes of animal production component could be summarized as follow :**

1- Training farmers on animal husbandry and improving animal performance and milk harvest.
2- Providing farmers with Frafra ram improved farmers' income giving twins out of cross breeding .
3- Increasing milk production by feeding the animals on concentrates provided by the project as well as improving fattening .
4- Capacity building in animal housing , veterinary, nutrition aspects and generally in animal husbandry.
5- Capacity building in milk preservation and processing which helped in increasing their incomes.
6- Increasing farmers' income by selling milk to the milk point with higher prices and losses due to not selling the milk were reduced or stopped.

## *CONCLUSION*

Planting wheat and other crops on raised beds increased grain yield , decreased costs of seeds , fuel and labor costs. Crop intensification increased farmers' income and improved soil characteristics. Making silage saved environment from pollution and increased farmers' income .

Livestock management as a component of the mixed farming system needs capital assets which became relatively high for small farmers despite socio-economic importance of livestock in rural communities. The project can provides one village in each district with a pilot milk collection unit to help farmers in marketing milk to increase their income in addition to training courses in producing other milk products.

**Number of beneficiaries within the activities undertaken 2014 through 2016.**

| Activity | Number of beneficiaries | |
|---|---|---|
| | **Extensionists** | **Farmers** |
| Training course in animal husbandry in Sakha training unit for ten days | 2 | 18 |
| Farm monitoring visits to farmers' house to update their knowledge in animal husbandry through biweekly visits to participants and neighboring | 8 | 60 |
| Making silage from corn stlks through ten demonstration in each village | 4 | 200 |
| Planting fahl berseem to apply three – crop intensification rotation | 4 | 50 |
| Training courses on managing the milk collection center (three courses in Assiut University and the milk collection center). | 12 | 48 |
| Training course in milk preservation and milk products in Assiut University for the owner and three assistants (10-day course). | -- | 4 |
| Planting wheat on raised beds | 10 | 280 |
| **Total** | **40** | **660** |

# ETHIOPIA (ARARI) FINAL TECHNICAL REPORT

Project: Improving smallholder farmer livelihoods in the Nile Valley and Sub-Saharan Africa Region through transforming research outcomes to create commercial opportunities (funded by IFAD- 2nd phase)

**Report Rain fed Ethiopia component**

## Technology package 1 : Improving farmers income from improved Kabuli chickpea and vetch production through linking farmers to a sustainable market

### Introduction

The main purpose of improved chickpea and vetch variety with their production is to increase the cash income of goat keepers through the sale of grain and at improving the feed availability and quality. In this area, chickpea is major crops for the famers and they have grown the local chickpea variety with traditional system. In addition, majority of farmers mainly get their seeds from informal channels which include farm saved seeds, seed exchanges among farmers or/and local grain/seed market. As a result of this the yield as well as the income generated from chickpea production are very low than what is expected. On the other side, feed shortage, especially during the dry season, is one of the major production constraints of the study area that contributes a lot for reduction of production and productivity of the livestock.

By considering this fact, Gondar agricultural research center tested participatory adaptation trail to test the adaptability of different chickpea and vetch varieties released in 2012 cropping season at Gumara-Maksegnit watershed. The result of the trails showed that as there is high potential to increase yield, income as well as feed availability in the area. Therefore, this activity is initiated to increase goat keeper's income through integrating improved chick pea and vetch production by targeting and creating sustainable market in the area. Research-to-business model approach will be used as a further development of organizational structure of the already organized community breeding program to be suitable as a market-oriented entity.

**Methodology/ Business plan**

In the watershed two Kabuli chickpea varieties (*Shasho* and *Arerti)* and two vetch varieties (*Vicia atropurpurea* and *Vicia villosa*) were selected through participatory variety selection studies conducted in the 2011 and 2012 cropping seasons. During the participatory variety selection study it was realized that by growing *Shasho* and *Arerti* farmers were able to gain 20% and 64% more income, respectively over growing the local variety. Furthermore, chickpea residue is a highly nutritious livestock feed widely used by farmers. On the other hand, Vetch varieties (*Vicia atropurpurea* and *Vicia villosa)* with a potential dry matter yield of 6.5 to 8.2 t $ha^{-1}$ were selected through participatory variety selection. By supplementing crop residue, which is the main feed resource for the long dry season in the area, the productivity of farmers' goat flocks could be improved. Goat fattening in the watershed is largely dependent on grazing, consequently goats are often marketed at low body weight. Therefore, through introducing the two Kabuli chickpea and vetch varieties with their agronomic packages farmers' income could be increased, farmland soil fertility could be maintained and feed availability and quality could be improved. By integrating goat production with chickpea and vetch production farmers can fatten their goats and sell goats at better prices.

For chickpea the technology package for the second phase includes two improved Kabuli chickpea variety *Arerti* with improved agronomic packages (row planting, proper weeding, bollworm control). The activities will be conducted for two years (2014-2016). In year one (2014), the project was implemented with the active participation of 42 farmers on a total plot of 20 hectares. Each participating farmer has planted 0.25 ha of land to improved varieties. There were two clusters one at each village of Das Dinzaz and Degola Chinichaye villages. Each cluster grew only one of the varieties.

For vetch, the technology package includes two improved vetch varieties (*Vicia atropurpurea* and *Vicia villosa*) with improved agronomic packages (row planting, proper weeding, insect control). In year one (2014), the project was implemented with the active participation of 32

farmers on a total plot of 4.5 ha. Each participating farmer planted 0.125 ha of land to either of the vetch varieties. The activity was done Das Dinzaz and Degola Chinichaye villages.

The business platform actors were Gonder Agricultural Research Center, Zone and District extension departments, Tsehay farmer's cooperative Farmers' Union, Amhara Seed Enterprise, Kabuli chickpea producing farmers, retailers, whole sellers, consumers, NGOs. Gondar Agricultural Research Center in collaboration with district office of agriculture selected and trained farmers and extension workers, delivered seeds of Kabuli chickpea varieties, organized field days, implemented and monitored activities, facilitated and monitored the functioning of the business model. IFAD project provided budget and technical backstopping. North Gondar Zone Administration office and Department of Agriculture and Gondar Zuria District Administration office played facilitation role. North Gondar Zone and Gondar Zuria District Cooperatives Offices linked farmers to market. Gondar Zuria District office of Agriculture selected farmers and organized clusters, organized field days, trained farmers and monitored implementation. Gondar Seed Laboratory office inspected the seed production process and certified the seed. Tsehay farmer's cooperative Farmers' Union is in the process of buy the seed.

A planning workshop was held with farmers and business platform actors to have common ground and understanding on the research objectives and processes. Roles and responsibilities of actors and detailed activities were jointly planned in the workshop. Training on the production and management of chickpea and vetch were given to participant farmers.

Two field days at vegetative and maturity stage were organized to assess farmers and local policy makers views and reactions. Data on farmers (participating and non-participating) reaction was collected. Sample yield from the Kabuli fields and from farmers field who grow the local variety were collected using quadrant. Production costs (seed cost, fertilizer cost, labor cost etc.) and product prices were collected and analyzed using simple descriptive statistics and CIMMYT's partial budget and sensitivity analysis tool to compare the economic impact of improved chickpea technologies with farmers practice.

**Methodology**

Agricultural research results have been often reported to have immense impacts on productivity. However, agricultural research needs to think beyond increasing productivity-transforming research results to business to enable smallholder farmers to fetch more cash from the research results. This could be realized by establishing a research to business model (R2B) where businesses are taken as part of the solution to poverty reduction. The research to business model should work in such a way that partnerships, which include private sector, smallholder farmers and government, are key to gaining greater access to markets for small farmers so that they can increase their incomes.

Research–to-business (R2B) model/approach is used to develop the organizational structure of the already organized community breeding program. R2B model facilitated linking up small- and medium-sized enterprises and smallholder farmers, in a mutually beneficial relationship between smallholder farmers and the private sector.

The technology package used was improved Kabuli chickpea varieties (*Arerti*) with improved agronomic packages (row planting, proper weeding, bollworm control). The activity has been conducted for two years (2014-2016). In year one (2014), 42 farmers planted *Arerti* chickpea variety on a total plot of 20 hectares. Each participating farmer allocated at least 0.25 ha of land to improved varieties. There was two clusters one at each village of Das Dinzaz and Degola Chinichaye villages. Clusters were created by considering adjacent fields. Selecting participating farmers and clustering were carried out in collaboration with the district office of agriculture and development agents. In year two (2015), in addition to the 42 farmers of 2014 the technology package further implemented on about 99 more farmers with a total farm size of 37.5 ha. In total, in the two years about 141 farmers with a total farm size of 57.5 ha were reached and covered by improved varieties.

A series of workshops were being held with farmers and business platform actors to have common ground and understanding on the research objectives and processes. Roles and responsibilities of actors and detailed activities jointly planned in the workshop. Then after, training on the production and management of chickpea was given to participant farmers.

Field days at different growth stage in both years were organized to assess farmers and local administrators' views and reactions. Data on farmers (participating and non-participating) reaction were collected. Sample yield from the Kabuli fields and from farmers field who grow the local variety was also collected using quadrant. Production costs (seed cost, fertilizer cost, labor cost etc.) and product prices have been collected and analyzed using simple descriptive statistics and CIMMYT's partial budget and sensitivity analysis tool to compare the economic impact of improved chickpea technologies with farmers practice.

**I. Research to Business model (R2B)**

To convert research outputs to business sustainably, community based goat breeding participants used as an entry point for chickpea community based seed production. Community based goat producers were organized in a cooperative as goat husbandry and marketing cooperative at Dinizaz kebele. The main purpose of organizing farmers in goat market association is to generate better income for farmers who are organized in community breeding program. This cooperative can serve the bases for goat keepers to create horizontal coordination to goat keepers in a scalable structure and the vertical coordination with key buyers of their produces.

The business platform actors were Gondar Agricultural Research Center (GARC), Zone and District extension departments, Tsehay Farmers' Union, Amhara Seed inspection and regulatory office, Kabuli chickpea producing farmers. GARC in collaboration with district office of agriculture selected and trained participant farmers and extension workers, delivered seeds of Kabuli chickpea variety, organized field days, implemented and monitored activities, facilitated and monitored the functioning of the business model. North Gondar zone and Gondar zuria district Cooperatives Offices have linked farmers to market. Gondar Seed Laboratory office were certified the seed after they have done field visit. Tsehay Farmers' Union purchased the produced seed through primary cooperative by giving 15% premium price.

Partnership meeting/discussion was held at Gondar among potential partners (GARC/IFAD, N2Africa, SNV and Tsehay union). During the meeting an agreements were reached to create

synergy and Common activities like training, field day and etc were identified and planned together. Roles and responsibilities of each partner were identified and thus Memorandum of understanding (MOE) was signed among these partners.


Fig.1The Research-to-Business Model of North Gondar

For sustainably to convert research outputs to business, goat husbandry and marketing cooperative was established at Dinizaz. The main purpose of organizing farmers in goat market association is to generate better income for farmers who are organized in community breeding program. In the breeding program in every six months, there is bucks selection based on farmers and breeders criteria. Only few bucks will which met the criteria will be selected and the others will be culled and supplied to the market. In addition old bucks and does in the stock should be either consumed at home or sold to the market. If these farmers organized and linked to the market they can fetch better price collectively.

This cooperative can serve the goat keepers to create horizontal coordination of goat keepers in a scalable structure (allowing community-based breeding as well as the marketing of agricultural commodities) and the vertical coordination with key buyers of their produces. Goat husbandry and marketing cooperative plays a key role to establish research-to-business model sustainably by following the value chain of a given commodity. To meet this assumption through the collaboration of the district office of cooperative, goat husbandry and marketing cooperative was established at Dinizaz. Of the 62 community goat breeding members 42 members were pay the registration fee and buy share. The members decided to contribute **300 birr** each to be the initial

capital. (**250 birr for share+50 registration fee).** They have opned bank account in the name of the coomeratives and elected excutive, auding, marketing, credit committee. The coopertive is now under the process to get legal cerificate from the district cooperative offcice.

## II. Participant selection and area clustering

Participant selection criteria were developed by GARC and Gondar zuria office of agriculture. Participant farmers' selection and area (farmers' field) clustering were carried out by Gondar Zuria office of agriculture experts and DA's. Two clusters (Das Dinzaz and Degola Chinichaye villages) were selected. In 2014, A total of 20 hectare on 42 farmers' adjacent field (at least 0.25 ha on each) was selected and covered with improved variety. In 2015, scale 37.5ha of land on 99 farmers' selected. In the two year about 57.5 ha of land from 141 farmers covered with improved chickpea technologies. Basic seed was purchased from Tsehay union (partner) and distributed to participant farmers through in kind loan.

**Table 1. Chickpea participants and input distribution for community seed production**

| Location (Kebele) | Year | Area(ha) | Amount of seed (qt) | Inoculant sacts) | No of participant farmers | | |
|---|---|---|---|---|---|---|---|
| | | | | | Male | Female | total |
| Das Denzaz | | 10 | 10 | - | 21 | 1 | 22 |
| Degola Chinchaye | 2014 | 10 | 10 | - | 20 | 0 | 20 |
| Das Denzaz | | 18 | 18 | 25 | 54 | 0 | 54 |
| Degola Chinchaye | 2015 | 19.5 | 19.5 | 25 | 45 | 2 | 47 |
| Total | | 57.5 | 57.5 | 50 | 138 | 3 | 141 |

## III. Capacity development

The main purpose of training was to build farmers and extension workers skills and knowledge on chickpea technology packages. In the two implementing years different training sessions were organized. The topics covered during the training included improved legume production agronomic practices and disease and pest management given by legume breeder and pathologist, inoculation given by soil agronomist, quality seed production(chickpea) by socio-economist & zone seed inspection expert, marketing (district cooperative expert), post harvest handling and market linkage/market chain. As shown in the following Table training was given for a total of 255 farmers (7 women) and 38 experts who are from zone and district office of agriculture and DAs.

**Table 2. Participants of the training at different time**

| Technology | year | Kebele | No of participant farmers | | | No of Experts /DAs | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Total | Male | Female | Total |
| | 2014 | Degola | 24 | 0 | 24 | 4 | 2 | 5 |
| Chickpea | | Dinizaz | 26 | 3 | 29 | 3 | 3 | 6 |
| community seed | | Degola | 54 | 0 | 54 | 8 | 2 | 10 |
| prodn | 2015 | Dinizaz | 45 | 2 | 47 | 1 | 2 | 3 |
| Chickpea post | | Degola | 54 | 0 | 54 | 8 | 2 | 10 |
| harvest & | | | | | | | | |
| marketing | 2015 | Dinizaz | 45 | 2 | 49 | 1 | 2 | 3 |
| **Total** | | | **248** | **7** | **255** | **25** | **13** | **38** |

**IV. Field day for technology popularization and Demand creation**

The main purpose of undertaking the field days was to create demand on chickpea technologies, create and strengthen linkage among stakeholders(enablers) who work on to improve chickpea value chain and finally to enhance technology multiplication and dissemination system. The field days were done on both kebele's. In each year, at Degoalkebele 3 clusters were visited by participants while at Denizaz, of the 2 clusters were visited by participants

As shown in the following tables about 255 farmers and stakeholders from different levels were participated in the field day. At regional level: ARARI senior researchers of crop and socio-economics research directorates, public communication were participated. At Zonal Level: Zonal Office of Agriculture, Zonal of cooperative promotion, Tsehay Union, Zonal office of Seed inspection, North Gondar - livelihood improvement and sustainable resource management program, GARC, Ethiopian television were participated. At Districts level:- District office of Agriculture, cooperative, World vision and DA's of both kebeles were participated in the field day.

At Both kebeles Arerti Variety with its technology packages compared with local ones were demonstrated to the participants. Briefing and explanation were given to the field day participants about chickpea technology packages, how the by-products can be utilized for goat producers as feed to their goats and the participatory process and how this scaling up activities will be continued sustainably. During the each field days farmer's reactions on *Ararti* technology package were collected. They have suggested that the main advantage *Ararti* variety and the technology packages compared to local variety and practices were

- *Arerti* variety is resistant to drought and disease
- Row planting has brought vigorous growth but it demands high labor
- 2-3 times plowing reduces weed and diseases infestation
- *Arerti* variety has good branching ability and its biomass is will be good source feed goat and other livestock
- *Arerti* variety has large number of pods per plant
- *Arerti* variety large seed size preferred by market

Finally, at the end of each field day the participants had intensive discussion about how to sustain the system for long time without any other external support. Furthermore, the seed production and marketing procedure, criteria on quality seed production, the roles and responsibilities of the local institutions were briefly discussed.

**Table 3. Chickpea field day participants**

| Kebele | year | Participant farmers | | | Stakeholders from Districts | | | Stakeholders from Zonal office | | | Stakeholders from Regional offices | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | female | Total | Male | female | Total | Male | female | Total | Male | female | Total |
| Degola | 2014 | 56 | 21 | 77 | 13 | 5 | 18 | 4 | 1 | 5 | 3 | 1 | 4 |
| Dinzaz | | 43 | 4 | 47 | - | - | - | - | - | - | - | - | - |
| Degola | 2015 | 42 | 6 | 48 | 7 | 4 | 11 | 3 | - | 3 | 3 | - | 3 |
| Dinzaz | | 75 | 17 | 93 | 8 | 3 | 11 | 2 | - | 2 | - | - | - |
| Total | | 216 | 48 | 265 | 28 | 12 | 40 | 9 | 1 | 10 | 6 | 1 | 7 |

**V. Market linkage**

Market linkage was created for community seed producer participants. A number of steps were followed to link the seed growers to sustainable market. First the plan was discussion with key stakeholders (office of seed inspection and regulation, district office of agriculture, district office of cooperative and Tsehay union). During the discussion it was reached in agreement that GARC has to develop some selection criteria to select participant farmers. The criteria used to select the participant were the participant must be a member of goat community-based breeding program, must have willingness to participate for seed production, the participant field must be clustered, there should not be any other chickpea filed in the nearby to keep isolation distance etc. Based on the stated criteria GARC with The collaboration of district office of agriculture about three clusters and participant farmers were identified. Thenafter one day training was given as how to produce quality seed which met inspection criteria for the participants. At this stage farmers were agreed to produce the seed and each stakeholders took their roles and responsibilities. The other important and challenging work was to get certified basic seed. This assignment was given to Tsehay union. Certified seed was purchased from Tsehay union and distributed to the participant farmers. To collect the produced seed it was agreed that Tsehay union would collect through primery cooperative than an agreement paper were signed between Tsehay union and the two primary farmers cooperative found at Dinzaa and Degola. The two primaries have got 20birr

margin per quintal. Finally, GARC with the collaboration of district office of Agriculture has put the technology on the ground based on the recommended chickpea technology packages.

Regarding field seed inspection, it was jointly done by a team composed of zonal seed inspection office, Tsehay Union, GARC and Office of Agriculture. During the field inspection all farmers field was visited by team. the main purpose of seed quality control is to identify those fields which can qualify quality seed production. Farmers' field which met the inspection criteria were selected and used as seed for next year and linked with market. About 72 farmers' field out of 99 participant farmers field passed the seed criteria. The estimated amount of seed that can be collected and used as seed for next year was about 333qt of seed. Here after, a one day workshop was held with key market actors and stakeholders, Tsehay union agreed to purchase the seed by giving 15% premium price from the market. Currently, Tsehay union have collected 150 quintal of the chickpea seed produced by farmers through multipurpose primary cooperatives found in the two kebeles.

**III. Yield adavantage and finacial analysis**

Sample grain yield were collected from host farmers' field and neighboring farmers field. Since kabuli chickpea was introduced for the first time, there is no local kabuli chickpea in the area. However, the comparison was done with the dessi type. Farmers widely grow dessi type for many years. The highest yield recorded from the *Ararti* variety was 1645kg/ha and the lowest was 1263kg/ha while the highest and the lowest yield of sampled local variety were 920 and 628kg/ha, respectively. The improved kabuli type variety (*Arerti*) gave a mean seed yield of 1488 kg/ha while the local dessi type gave 814kg/ha. This means that kabuli chickpea variety had a yield advantage of 674 kg/ha over the local one. The yield of chickpea in this production year was law due to high ball worm infestation.

The partial budget analysis was carried out for the improved variety against the local check using CIMMYT (1988). Based on the input and out price illustrated on table 4, the marginal rate of return for *Arerti* variety over local is 601.37%. This means that farmers who grow *Arerti* kabuli chickpea variety with its improved production packages earned a higher margin than those who

produce local variety. The figure obtained is greater than the generally accepted minimum rate of return i.e. 100%. The heist earning is a result of higher productivity of the variety in one side and the market linkage created for chickpea seed producers using R2B approaches. This implies that for one birr additional cost on the use of *Ararti* variety over local have a return of birr 6.01, over the local variety.

Table 4. Partial budget analysis

| **Items** | **Local** | **Improved** |
|---|---|---|
| Mean GY (kg/ha) | 814 | 1488 |
| Adjusted yield (kg/ha) | 732.60 | 1339.20 |
| Gross Field Benfit (ETB/ha) | 6512.00 | 12052.80 |
| Labor cost (ETB/ha) | 0.00 | 240.00 |
| Seed cost(ETB/ha) | 770.00 | 1320.00 |
| Total Cost that Vary (ETB/ha) | 770.00 | 1560.00 |
| Net Benefit (ETB/ha) | 5742.00 | 10492.80 |
| Marginal Cost (ETB/ha) | | 790.00 |
| Marginal Net Benfit (ETB/ha) | | 4750.80 |
| Magrginal Rate of Return (%) | | **601.37** |

**Conclusions and the way forward**

It was found that *Arerti* kabuli chickpea variety is high yielder, financially feasible and socially preferred by the farmers. Therefore, the *Arerti* variety should be scale out to boost production and productivity in similar area. Though the seed business is challenging and need some special care, it was highly profitable and has high market demand. The R2B approach on the other hand found to be a good approach that converts the research output in to income generating option for the poor famers. The local institution should further follow up closely the seed production and strengthen the cooperative and the union to make them competent in the market and to sustain the system.

It was observed that introduction of new variety and creating seed business need some lag time between them. It would be good first to have sufficient time in order to create demand on the technology before converting it into business. During the first year it was observed that farmers prefer to check the well working of the technology than producing quality seed and selling to the market. Therefore, in the begging more focuses should be given on demand creation/ introducing the variety to the area than seed production. Seed production needs special attention like (keeping isolation distance and other seed production parameters). At the same time producers need to be certified to sell the produce as a seed. In addition, there must be legalized entity to run the financial system smoothly (Degola and Dinizaz multipurpose cooperative is still at infant stage).The established cooperative need close follow up to strengthen and be competitive in the market.

**Challenges encountered to implement R2B**

During the implementation of R2B model the following challenges were encountered

- It was difficult to get certified seeds at the beginning
- At the first year, farmers are more interested on the technology than seed production
- Area clustering was challenging unless all the neighboring farmers included
- Farmers had no experience and willingness to rogg out /remove the off-type and other weeds in the first year
- Bollworm was difficult to control
- Getting legal entity for community based goat husbandry and marketing cooperative took lengthy time
- At the first year, the primary cooperative had not enough capital to purchase the produced seed. To solve the problem Tsehay union agreed to transfer the seed money for Primary cooperative. However, the process took some time (opening an account for the primary cooperative and arranging their facilities, cleaning store etc) in the meantime farmers was not sold the produce as a seed.

**Lesson learnt**

- Seed production needs field clustering
    - There should not be other variety in the nearby
- Seed inspection
    - Knowing seed production standards ahead and involving the inspectors starting from the beginning is crucial
- Institutional arrangement
    - Certifying the established Goat husbandry and production cooperative to use as a node to sell the seed
- Market linkage
    - Involving Tsehay union starting from the beginning and signing a memorandum of understanding played a key role
    - Participant farmers should sign contractual agreement with the established cooperative

## Technology package 2: up-scaling community-based goat breeding for improved meat production

### Introduction

Goats are mostly kept by smallholders and the rural poor, including women-headed households. They contribute substantially to the livelihoods of Ethiopian smallholder households as a source of income, food (meat and milk), and non-food products such as manure, skins and wool. They also serve as a means of risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions. At the farm level, goat contributes up to 63% to the net cash income derived from livestock production in the crop-livestock production system. However, Goat production in Ethiopia is constrained by many

factors among these high prevalence of disease, feed shortage and lack of appropriate breeding schemes are the major ones.

Previous studies have shown that indigenous Ethiopian goat and sheep breeds have the potential to produce more and better meat and skins, so long as they are fed, managed and bred better. To do this, farmers need to be organized to continuously retain and access better breeding rams, forestall inbreeding, and have better access to markets. Community-based breeding program approach offers promise in this regard.

Community-based breeding programs are being implemented in few places in Ethiopia. Since 2013 in Gumara-Maksegnit watershed in Dinzaz village the approach has been designed and implemented and encouraging results were obtained. Results from these programs have demonstrated that improved flock productivity is achievable at community level. Some of the strategies that have been successfully employed are; a) jointly developing and agreeing on breeding objectives with the communities and b) then implementing this, by selecting young bucks based on the agreed criteria and buying and retaining selected "best" young bucks and rotating them among group members (livestock keepers), while sharing the costs of keeping these bucks within the group. However, such programs and outcomes need to be up-scaled and out-scaled in order to have wider impact at regional and national level.

Here we propose both an improvement program and up scaling strategy whose overall goal is: **"***To enhance productivity from goat by implementation of effective and efficient goat improvement program and providing* improved market opportunities for goat and goat products *in order to improve food security, livelihoods of the rural poor, while ensuring the broader environmental health*".

**Part one: The results from the Phase one (DinzazVillage)**

***Community Mobilization***

Prior to commencement of the actual field work, the community were sensitized about objectives, intentions and possible outcomes of the project for their genuine participation during data collection. Accordingly, community meetings were organized at the village. The meetings were generally helpful in establishing mutual understanding with the local people while avoiding

unrealistic expectations. During the meetings, the research center and participant farmers agreed to participate in the selection of breeding sires/bucks and to cull the unselected ones to avoid uncontrolled mating in communal grazing land or watering points. Synchrony and agreement on when and how to cull undesirable males and on effective use of the selected young males for breeding before they are sold off were reached. After this agreement, village level goat improvements with 60 participants were established at *Dinzaz* village. The participants have been grouped in 12 buck user groups based on their proximity and number of breeding does to facilitate easy management of selected bucks.

***Data collection and Follow-up***

To restrain goats and facilitate selection of superior sires by farmers, temporary wooden crash (holding yard) were constructed at the village. ID number on plastic ear tags was given for all goats of the participants. Two trained enumerators were employed at the village for day to day follow-up of activities undertaking by 56 participant farmers. Moreover, farmers' perception and other relevant data (productive and reproductive performance data) continuously have been collected throughout the experimental period.

***Bucks selection and management***

Two rounds buck selection based on simple sire selection and two rounds bucks selection based on performance recording have been undertaken. The mean of the selected bucks and their counter parts are described in table 1. A total of 27 breeding bucks were selected based on simple sire selection methods (without recording). A total of 18 bucks (12 in the first round and 6 in the second round) have been selected based on their performance recording. In first round 30 candidate bucks were presented for the final selection and among them 12 best bucks were selected based on their performance recording. Similarly, in the second round selection 6 best bucks were selected from 15 candidate bucks. The prices of the selected sires were paid for the owners. The selected bucks have been distributed to the organized bucks' user groups based on a reasonable male to female ration. The bucks were rotated between the buck user groups to avoid

inbreeding problems. Undesirable males were culled before they reach puberty (i.e. before they can serve) through castrating, selling or slaughtering.

Pictures during bucks selection

Table 1 the number and the mean weight of the candidates and the selected bucks at six months of age

| **Round of selection** | **Potential candidates** | **Selected bucks** | **Proportion of Selected** | **Mean of contemporary** | **Mean of selected** |
|---|---|---|---|---|---|
| 1 | - | 15 | - | - | - |
| 2 | - | 12 | - | - | - |
| 3 | 90 | 12 | 0.13 (12/90) | 17.25 | 20.4 |
| 4 | 37 | 6 | 0.16 (6/37) | 17.78 | 20.83 |

***Farmers training and experience sharing***

Training for farmers was given three times on improved animal husbandry practices. Six research staffs, 17 participant farmers and 1 enumerator were participated in the experience sharing tour to visit Menz sheep selection program at Molale, Debre Birhan Agricultural Research Center.

**Field day**

One day field day was organized to create awareness for different stakeholders on community based goat improvement and to facilitate the scale up of community based livestock breed improvement at zonal and regional levels. A total of 134 participants, 121 male and 13 female, from different disciplines were attained in the field day. During the field day the following major events were undertaken

- Introduction of the overall research activities in Gumara-Makesegnet watershed
- Introduction on the principle and procedure of community based goat implementation by researchers and participant farmers
- Selection of best bucks and best does by farmers representatives
- Animal show and award for best young bucks, best old bucks and best does
- Award for best performing participant farmers
- Discussion on how to scale up the community based goat improvement in different part of the Zone

*Pictures during field day and animal show*

***Data analysis for performance recording data***

Prior to analysis, the data was checked using scatter plot method of SPSS and the largest and smallest out layer values were filtered out from the data. Data were analyzed using Statistical Analysis System (SAS) version 9.1.3. Productive data (birth, three month six month, nine month and yearling weight) were analyzed using GLM of SAS. The fixed effects of sex, parity, type of birth, year of birth and season of birth were considered in the model.

***Preliminary results of flock performances***

***Growth performances***

***Birth weight***

The birth weight of the local goat in the study watershed is presented in Table 2 considering sex, parity, type of birth and year of birth as influencing factors. The overall least square mean of birth weight of Central Highland kids was 2.53±0.064 kg.

Except year of birth, all factor considered in this study showed the significant influence on birth weight. Male animals had significantly ($p<0.05$) higher birth weight than female counterparts. Single born kids were heavier ($P<0.001$) at birth than those born as twin & triple. This difference may be due to the effect of maternal influence. Kids born from the first parity had significantly lower birth weight than the kids born from the other parities.

***Three month weight***

The overall least square mean weight of Central Highland goat (local goat breed in the study watershed) at three months of age obtained in this study as presented in Table 1 was 8.23±0.22 kg.

Analysis of variance showed that type of birth had significant ($P<0.01$) effect on three months weight while other factors had no significant ($P>0.05$) effect. Single & twin birth types were heavier ($P<0.01$) than those born as triple.

***Six month weight***

The overall least square mean weight of Central Highland goat local goat breed in the study watershed) at six months of age obtained in this study as presented in Table 1 was 11.86±0.35 kg. Type of birth showed a significant ($P<0.05$) influence on six month weight. Sex, parity and year of birth had no significant ($P>0.05$) influence on six months of weight of this study.

***Nine month weight***

The overall least square mean weight of Central Highland goat at nine months of age obtained in this study as presented in Table 1 was 15.39±0.47 kg. All fixed factors showed no significant ($P>0.05$) influence on nine month weight of Central Highland goats.

***Yearling weight***

The overall least square mean weight of Central Highland goat at yearling age obtained in this study as presented in Table 1 was 19.41±0.53 kg. All fixed factors considered in this study had no significant influence on yearling weight

***Litter size***

From the total of 527 kids born, 244 kids were born as single, 272 were as twin and the rest 12 kids were born as triple. This means 46.2% were single births, 51.5% were twin births and 2.3% were triple births. The overall mean ± SD litter size of this study was 1.56±0.54.

Table 2. Factors affecting birth, three and six month weights of Central Highland goat (local goat breeds of the study watershed) breed

| Sources of Variation | Birth Weight (Kg) | 3 Months Weight (Kg) | 6 Months Weight (Kg) | 9 Months Weight (Kg) | 12 Months Weight (Kg) |
|---|---|---|---|---|---|
| | LSM±SE | LSM±SE | LSM±SE | LSM±SE | LSM±SE |
| Overall | 2.53±0.064 | 8.23±0.22 | 11.86±0.35 | 15.48±0.36 | 19.41±0.53 |
| CV% | 22.6 | 17.37 | 18.13 | 11.48 | 7.52 |
| Sex | * | NS | NS | NS | NS |
| Male | 2.59±0.07 | 8.26±0.24 | 11.90±0.36 | 15.66±0.37 | 19.66±0.57 |
| Female | 2.46±0.07 | 8.19±0.24 | 11.82±0.38 | 15..31±0.38 | 19.16±0.70 |
| Type of Birth | *** | ** | * | NS | NS |
| Single | 2.90±0.04[a] | 8.81±0.13[a] | 12.76±0.22[a] | 16.00±0.28 | 19.74±0.86 |
| Twin | 2.68±0.04[b] | 8.71±0.13[a] | 12.56±0.21[a] | 15.47±0.28 | 19.08±0.55 |
| Triple | 2.00±0.18[c] | 7.15±0.63[b] | 10.26±0.97[b] | 14.98±0.84 | |
| Year of Birth | NS | - | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| **2013** | **2.50±0.06** | **-** | **-** | **-** | **-** |
| **2014** | **2.55±0.07** | **-** | **-** | **-** | **-** |
| **Parity** | ***** | **NS** | **NS** | **NS** | **NS** |
| **1** | **2.32±0.10** [a] | **7.99±0.38** | **12.01±0.53** | **15.37±0.37** | **18.69±0.73** |
| **2** | **2.63±0.10** [b] | **8.18±0.32** | **11.86±0.49** | **15.14±0.48** | **17.97±0.76** |
| **3** | **2.57±0.09** [b] | **8.57±0.32** | **12.15±0.49** | **15.39±0.47** | **18.25±1.48** |
| **4** | **2.55±0.09** [b] | **8.49±0.29** | **12.78±0.44** | **15.69±0.42** | **20.10±0.98** |
| **5** | **2.44±0.08** [b] | **7.93±0.29** | **11.52±0.46** | **15.01±0.43** | **18.80±0.88** |
| **6** | **2.60±0.10** [b] | **7.92±0.32** | **10.98±0.51** | **15.20±0.46** | **18.21±1.37** |
| **7** | **2.57±0.13b** | **8.38±0.30** | **11.73±0.48** | **16.57±0.53** | **20.86±0.85** |

*N= number of observations; NS = non-significant; *P< 0.05; ** P< 0.01; *** P< 0.001*

**Part 2 Progress Report on Phase Two (Chinchaya and Denkele villages)**

**Site selection and community mobilization**

After consultation of the development agents working on the livestock extension, two villages (Chinchaye and Denkele) which are close to the old village (Dinzaz) were selected based on the relative importance and population size of goats. Before implementation of the actual work, village level meeting were held to clarify about the procedure and the importance of community based breed improvement. After the meeting, farmers were agreed to participate and to follow the community based breed improvement procedures such as providing the performance data of their animals to the enumerators and to use only the selected bucks and to cull the unselected bucks. Following the village level meeting, a total of 103 (56 from Chinchaye and 47 from Denkele village) have been registered as a participant farmers.

**Data collection and monitoring**

Identification numbers with Plastic ear tag were given for all goats' population of the study villages. The base line information of the animal such as age, color and weight were recorded at the beginning of the work (Table 3 ).Three trained enumerators have been employed for collecting the growth performances, reproductive performances, health data and off take rate.

Table 3 Flock structure and weight of base population goats

| Age *sex group | No. | Proportion | AV.Weight(kg) |
|---|---|---|---|
| Does | 300 | 0.49 | 28.00 |
| Does kids | 87 | 0.14 | 16.70 |
| Bucks | 38 | 0.06 | 25.84 |
| Bucks kids | 53 | 0.09 | 15.55 |
| Female kids | 60 | 0.10 | 12.92 |

| | | | |
|---|---|---|---|
| Male kids | 76 | 0.12 | 10.68 |
| Total | 614 | 1.00 | 22.80 |

**Bucks selection and management**

As the performance recoding is at early stage to select bucks based on their performance record, one round simple sire selection (without recording) have been undertaken. All breeding male goat available in the village were presented as the candidate animal. Among them 11 best bucks, the bucks having good physical appearances, color and horn were selected through the participation of the farmers. Following the same procedure at Dinzaz village, the prices of the bucks were paid to the owners. The bucks have been distributed to the participant farmers based on the male to female ratio (1:15-20) and the neighbourhood of farmers.

**Economic impact assessment**

The household survey from participants and non participants have been undertaken to asses the economic impact of village based goat improvement. The data is being processed.

**Future plan**

- **Biological data collection**: The productive and reproductive performance and other relevant data will be collected through the enumerators by close supervision of the researchers from Gondar Agricultural research center. The main propose of the data collection are; to select the best bucks based on their performance and to evaluate the biological performance before and after selection.
- **Field day**: Eight field days, one field day for 50 farmers, will organized to further reach out the remaining goat keepers (400 households) in the watershed.
- **Scale up**: Based on the lesson from the three pilot villages, the community based breeding scheme will scale up to 400 households.
- **Organizing workshop**: Stakeholder workshop will be organized to present the result of the project and to discuss on further scale up of the activity at the national level. During the

workshop the policy makers at national and regional level, the relevant expertise from different governmental and nongovernmental organization, researchers working in the national and international research centers will be invited.

# ETHIOPIA (EIAR) FINAL TECHNICAL REPORT

# ETHIOPIAN INSTITUTE OF AGRICULTURAL RESEARCH (EIAR)

- Integrated Agricultural Production Systems for the Poor and Vulnerable in Dryland Area


Dr. Tesfaye Shimbre
Dr. Tilahun Hordofa
(Dr. Adam Bekele)
Dr. Bedru Beshir
‘


22 -25 November 2015

Cairo, Egypt

# Integrated Agricultural Production Systems for the Poor and Vulnerable Farmers in Dryland Area of Arsi-Negele

General Objective

To enhance food security, livelihoods and adaptive capacity of resource poor farmers to cope with climate variability and change in dry areas

---

**Specific Objectives**

1. Development of profitable and climate change-proof packages/models of tested and proven technology options
2. Facilitation of the institution and policy environment for an accelerated scaling up of these technologies.

Project Site – Gedemso - Boku Wolda Farmer's village
Arsi-Negele - Ethiopia

# The Project Site


**Purpose of the project:**
Contribute to the overall IFAD goal of enabling the rural poor to overcome poverty by income generation, improved nutrition and environmental sustainability

# Climatic Condition of Gedemso

| Month | Rainfall (mm) | Temperature (°C) | | RH ( % ) | Wind speed Km hr$^{-1}$ | Sunshine (hr.) | ETo (mm day$^{-1}$) |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | | |
| January | 28.8 | 26.4 | 10.1 | 50 | 86 | 9.3 | 4.0 |
| February | 51.4 | 27.0 | 11.0 | 48 | 86 | 9.4 | 4.4 |
| March | 65.6 | 27.6 | 11.8 | 50 | 95 | 8.4 | 4.5 |
| April | 84.7 | 27.4 | 13.0 | 56 | 86 | 8.5 | 4.5 |
| May | 90.9 | 26.3 | 12.7 | 64 | 86 | 8.6 | 4.3 |
| June | 97.7 | 25.2 | 12.6 | 66 | 112 | 8.7 | 4.2 |
| July | 138.2 | 23.4 | 12.9 | 72 | 69 | 6.2 | 3.4 |
| August | 116.1 | 24.1 | 12.9 | 70 | 52 | 6.1 | 3.5 |
| September | 113.7 | 24.5 | 12.6 | 70 | 60 | 6.0 | 3.5 |
| October | 47.8 | 25.6 | 11.1 | 63 | 60 | 8.3 | 3.9 |
| November | 21.5 | 25.8 | 9.5 | 54 | 86 | 9.3 | 4.0 |
| December | 7.1 | 26.0 | 8.3 | 48 | 86 | 9.3 | 3.9 |
| Mean | 863.5 | 25.8 | 11.5 | 59 | 81 | 8.2 | 4.0 |

Source: NewLocClim_1.10 (FAO, 2005) – Local Climate Estimator

# THE PROJECT

- Phase II of the project "**Integrated Agricultural Production Systems for the Poor and Vulnerable in Dryland Areas"** began with inception workshop held in April 2014.
- Phase I of the project **"Improving the Livelihoods of Rural Communities in the Nile Valley and Sub-Saharan Africa Regions: Sustainable crop and livestock management"** had been the springboard for phase II of the current project
- ICARDA is organizing and leading the project because of long-year research involvement in dry areas
- In Ethiopia, the project is running in two regions as "Component I and II" sharing same budget allocated for a country, half for component I and half for component II.

# THE PROJECT … Cont'd

- Component II of the project is located in Arsi-Negele region some 225 km from Addis Ababa and carried out in Boku Wolda village.
- Gedemso is one of IFAD investment project "PSSIDP (2010 – 2015)" site in Boku Wolda village considered for the implementation of this project
- The goal is to develop sustainable, resilient and economically viable production systems that contribute directly to food security and improved livelihoods by managing risks and enhancing the productive and adaptive capacity of farming communities in dry areas
- Phase II was based on the interventions tested and proven technologies in phase I
- On the base of Cairo meeting, April 2014 launching workshop, it was suggested to accommodate wheat, tef, poultry and apiculture commodities for research-to-business model.

# IMPROVED CROP-LIVESTOCK TECHNOLOGIES INTERVENED IN GEDEMSO DURING PHASRE I

**Horticulture Crops**

a)Onion bulb & seed production
b)Tomato fruit and seed production
c)Pepper
d) Potato

**Field crop packages**

a) Wheat Varieties
b) Barley Varieties
c) Maize (QPM & BH540 varieties)
d) Tef Varieties
e) Faba bean Varieties
f) Chick pea Varieties
g) Haricot bean

**Livestock**

- Artificial insemination
- Community-based small ruminant breeding/selection
- Bee-keeping

Wheat Field

FIELD DAY

Tef Field

# THE PROJECT … Cont'd

**Expected Output:**

- Elements of the research-to-business model identified.
- Value chain approach identified as a suitable conceptual framework for this model

**Work plan:** Include identifying villages, selecting farmers, inception workshops, organizing training, supplying crop technology packages, establishing IP, studying value chain, collecting data and etc.

| Annual budget | 1st quarter | 2nd quarter | 3rd quarter | 4th quarter |
|---|---|---|---|---|
| Eth. Birr 798,060.00 | 135,500.00 | 130,500.00 | 268,500.00 | 223.657.00 |
| US $ 39903 | 6775 | 6525 | 13425 | 11182.85 |

# Achivements

- The team of researchers after reviewing the project document decided to include two other villages - **Argeda and Degaga** and work on tef and wheat commodities for research to business model
- It was decided to pick a total of 45 farmers from the identified three villages (15 farmers from each village)
- List of potential farmers, male and female, was developed at each village with the participation of the respective village administrators/managers, supervisors and development agents
- However, lack of sufficient number of farmers (By then most farmers already planted), 10 farmers who can take the two crops together and another 10 farmers who can take the crops individually (i.e., five for wheat and five for tef) from each village.
- Farmers participating in Gedemsso were 15 growing wheat & tef
- The total farmers participating in the project were 55.

# Achivements … Cont'd

| Crop | F | M | Total | Remark |
|---|---|---|---|---|
| Wheat | 1 | 14 | 15 | From IFAD investment project site - Plots |
| Wheat | 4 | 16 | 20 | From Non IFAD investment project site - Plots |
| Tef | 1 | 14 | 15 | From IFAD investment project site - Plots |
| Tef | 4 | 16 | 20 | From Non IFAD investment project site - Plots |
| Total | 10 | 60 | 60 | Both IFAD and non-IFAD - Plots |

- The first budget released in mid June 2014 was 5,000 US $ and second budget released in mid December 2014 was in 10,000 US $
- For purchase of seeds and fertilizers plus travel expenses cost to more than 7,000 US $ and short by more than 2,000 US $
- Farmer usually harvest in October and as per implementation plan – inception workshop and other duties would have been done before October -

# Performance wheat and tef field






# Achivements … Cont'd

- Value chain for cereal based crop was identified to identify the actors and could not be continued further
- By Nov. 2014 visit was made by the regional project coordinator, Dr. Marwan, agreed to work on wheat during the rainy season (June–Sept.) and high value crops during dry season (Nov.-May) on the same fields irrigated by IFAD investment project and discontinue working under non-IFAD investment project site
- The research team was advise to work on the one or two high value crops (tested in Phase I) to be grown in this season (November – May) with the highest potential to be integrated in a value chain, benefiting the targeted smallholders
- Accordingly, Onion and Tomato was selected by the farmers for growing in the dry season (November-May)

# Achivements … Cont'd

- About 180 farmers were identified to grow onion and tomato
- Planting time for onion and tomato (Nov. – May) was delayed
- Seeds, fertilizers and chemicals for pest control were also distributed to 180 farmers

- Few farmers could not continue cultivating the crops as harvesting time approach the land preparation for rainfed agriculture

| Crop | Received | Cultivated | Shared cultivation | Not cultivated |
|---|---|---|---|---|
| Onion | 162 | 117 | 12 | 33 |
| Tomato | 18 | 13 | 2 | 3 |
| Total | 180 | 130 | 14 | 36 |

# Onion and Tomato Field

- Because of budget constrain could not continue identifying the value chain to find actors and link with market

# Achivements … Cont'd

- Third round budget request was released in April 2015 and made available in June at research center ((This time from EIAR side due to agreement not signed with ICARDA)
- It was then time to organizing the farmer as wheat producer and as a result 30 farmers were selected for growing wheat during rainy period
- Seeds and fertilizers were purchased and distributed to farmers for a quarter of a hectare
- All the farmers organized for cultivating wheat effectively implemented and harvested in October 2015
- For the second time, the regional project coordinator, Dr. Marwan made a visit in August 2015 and:
  - ❖ Observed the progress in implementing the IFAD-funded project
  - ❖ Discussed with the research team and,
  - ❖ visited project site and discuss with farmers

# Achivements … Cont'd

- It was agreed with the research team to:
  - ❖ conduct a socio-economic assessment and a SWOT analysis targeting the 60 participating farmers who cultivated improved wheat in the rainy season of 2014 and the 180 farmers who cultivated improved high value crops
  - ❖ identify potential buyers for improved wheat and high value crops
  - ❖ explore the potential role of the Irrigation Cooperative in the value chain of these crops
  - ❖ ensure Marketing of wheat for the 30 participating farmers through contract farming.
  - ❖ establish innovation platform
  - ❖ organize field days before the harvest
  - ❖ collect data and conduct socio-economic and performance assessment of the improved wheat cultivated in the rainy season by the 30 participating farmers.

# Achivements … Cont'd

**Actors within the vegetable value chains**

- Gedemso cooperative
  - has a total capital of only 265,000 birr (12,600 US $)
  - has a total size about 195 of which about 45 are females
  - did not start buying and selling of grain crops
  - started marketing of onion and tomato produce
  - produce was sold to Duro Langano Union (which makes up 17 primary cooperatives including Gadamso)
- Duro Langano Union
  - was not able to take all produce collected by the cooperative
  - brokers are interfering in the market and is the major problem
  - high transport cost to take the produce to the nearest town Arsi-Negelle

# Achivements … Cont'd

**Potential actors in the wheat value chain**

- **Duro Abaro Union**
  - is located in Arsi-Negelle town
  - has capital is 2.5 million (120,000 US $) and working capital sizes about 600,000 birr (28,600 US $).
  - Organized 17 cooperatives under this union
  - buys and sells wheat, barley, maize and haricot beans
  - Sells wheat for unions and Ethiopian Grain Trade Enterprise (EGTE)
  - lack of flexible contracting that EGTE sets fixed price and price on the market is much higher than the agreed price
  - prefers to base on the going market price

# Achivements … Cont'd

- **EGTE**
  - buys first grade grain, not the second grade or other
  - The farmers or the cooperative do not clean the grain to this standard
  - This makes it difficult for the union to meet up the EGTE's criteria
- **Lume-Adama Cooperative Union**
- **Uta Wayu Union Kaliti Food processing company**
- **Industries in Hawassa** did not come up with effective linkage that the industries were not interested
- **Food industries**
  - Africa PLC, the company is located at Adama
  - Brothers Biscuit Factory and,
  - Ahwan Floor Factory

# Achivements … Cont'd

- **Sureya Floor Factory**
- **Haji Mohammed Floor Factory**
- **Meti Teshome Floor**

**SWOT ANALYSIS**

- Group discussion has been carried out for SWOT analysis purpose. Members of Gedamso Small Scale Irrigation Cooperative and beneficiaries of the project gave their feedback on the **STRENGTH, WEAKNESS, OPPORTUNITIES and THREATS** with regard to production and marketing of tomato, onion and wheat. About twelve farmers participated for the discussion of the issues of which 3 are female farmers. (C:Desktop/Folderfiles/Phase II/SWoT)
- **Finally, much work remain and will continue with new AP in the second year**


Thank for Your
Attention!

# KENYA FINAL TECHNICAL REPORT

**IFAD- ICARDA Sub-Saharan and Nile Valley Regional Project (SSNVRP)**

Integrated Agricultural Production Systems for the Poor and Vulnerable Communities in Dry Areas

**Phase 2**

# Final Technical Report

## Kenya Component

*Sheep grazing on wheat straw stubble in Olulunga village, Narok, Kenya*

**G. A. Keya, P. Katiku, C. M. Mukisira, J. Nginyi, J. Manyeki, S. Amboga**

**May 2016**

## Executive summary

In May 2014, Kenya through KALRO was invited by ICARDA to be one of the six Nile Valley and sub-Saharan African countries to implement the second phase of the IFAD supported project *"improving integrated agricultural production systems for the poor and vulnerable communities in dry areas"*. The project goal is to enhance smallholder farmers' livelihoods in the Nile Valley and sub-Saharan Africa Region through innovative research to business (R2B) platforms. The specific project objectives are to a) develop and validate profitable R to B models of tested and proven technology options and b) disseminate successfully tested R to B models

In Kenya, the rainfed mixed sheep wheat production system in lower Narok is the designated country site. Smallholder wheat-sheep mixed farming systems in lower Narok- Kenya are characterised by low productivity and poor farm incomes. Challenges include adverse low and variable rainfall, high costs of inputs, lack of appropraite genotypes, pests and diseases, and lack of credit facilities, few storage facilities and poor marketing chnaels making farmers price takers at the mercy of middlemen. Additionally, farmers have limited access to improved crop and livestock husbandry skills and technologies, making them vulnerable to climate change impacts.

To initiate the project, a National Consultative Workshop was held in June 2014 with the objective of preparing the workplans and budgets for 2014/15 year. The workshop was also used to bond with the project team members and familiarize the stakeholders with objectives of the IFAD-ICARDA phase II project. This was followed by another workshop to revise and finalize the project concept and workplan. During this workshop scientists were sensitized on principles of on-farm participatory action research and criteria for selection of sites were discussed and agreed upon. Two sites were selected during field reconnaissance using objective criteria which included**.**

A baseline survey was conducted in the month of November 2014 to establish baselines on key aspects of the production system. From the baseline study it was evident that there have not been any opportunity for capacity building in sheep husbandry. The limited opportunities only existed for knowledge sharing amongst farmers themselves. Among the areas identified for capacity building include better husbandry practices, including cost-effective helminth control practices, better breeding practices that reduce the threat of in-breeding (castration of male culls, ram sharing, etc.) and for faster growth and high milk production, record keeping as well as feed conservation (especially with regard to enhanced utilization of wheat straw). Markets and marketing strategies that enabled sheep farmers to reap maximum benefits for the enterprise were also recommended. The survey also revealed that wheat farmers could improve their productivity by provision of capacity building support in some of the area identified in the baseline survey Options for addressing the marketing challenges in the wheat value chain (e.g. provision of storage facilities at village level) were elaborated based on the results of the survey.

A one day inception workshop, attended by 22 stakeholders, was held at KALRO Muguga centre on 20$^{th}$ January 2015. During this workshop, implementation protocols were discussed and action sites/points agreed upon. The workshop was also attended by ICARDA NVSARP Regional Coordinator Dr Marwan Owaygen. Results of the baseline survey were presented to the stakeholders and discussed. The R to B model was elaborated to the participants, discussed and agreed upon.

34 test farmers were selected and recruited to the action. The recruited group were mixed farmers, growing wheat and raising sheep on the same farm. Pilot sites for the testing of the sheep improvement technology were agreed upon and implementation roadmap developed.

To facilitate of adoption of improved sheep and wheat R to B model, 22 participating farmers (5 women and 17 men) of a local community based organisation (AFAPO) were trained on improved sheep and wheat management technologies. A field day was also held to showcase the wheat varieties and accompanying technologies. Three innovations platforms linking farmers to markets were held during the project period.

The selected wheat farmers were provided with five improved varieties to grow in a total of 68 acres (each farmer planted 2 acres). Planting was done in April 2015. However some farmers dropped out of the intervention. In total 54 acres of land was planted with wheat. Farmers agreed to thein the cost of production by meeting the cost of land preparation, weeding and other agronomic practices required. The level of input supply was left to the discretion of each farmer after getting training on improved management practices.

A menu of marketing options of improved wheat was identified for testing and validation with 20 members of a local community based organization (CBO). These options were: 1) direct sale at farm gate to brokers, millers and other wheat dealers, 2) sale to buyers through the National Cereals and Produce Board, and 3) marketing through a common storage facility established in the village. This latter option was emphasized by farmers during the stakeholder meetings. The best bet options targeted 300 farmers within the area.

Wheat harvesting, was done in July-August 2015 and the harvest marketed in three case scenarios outlined above. Farmers were asked to maintain records of yield and other of transactions. These records were used by the scientists to validate the marketing options and variety preferences in terms of yield and resilience to environment. It was noted that farmers sold their wheat at the farm gate, with only one of their counterpart selling to the millers. Results showed that most farmers realized profit from the wheat enterprise in the target area. However higher profit was made when wheat was sold as seed rather than grain. Selling wheat as grain to millers attracted additional costs in terms of drying, storage and transportation making it less profitable compared to selling at the farm gate. However the greatest gross margins would be obtained if farmers stored their wheat grain in a village storage facility to allow for a negotiated price. There is a need to further validate the village storage and pooling marketing model for wheat grain. Yield of improved wheat varieties was within the national average of 2-2.5 tons/ha for best producing varieties namely: Kenya Wren, Eagle 10 and Hawk. Kingbird, Robin and Njoro II varieties yielded less than 2 tons/ha and was therefore not suitable for the area in the rainfall condition prevailing during the study.

The R to B model for sheep, targeted the same group of 300 wheat producers. However initially the model was tested first with the CBO of 22 farmers, thereafter results would be disseminated to the wider 300 members in the village. Targeted producers had access to improved technologies and knowledge. Seven improved Dorper rams were purchased and provided to the group to improve on their local sheep. The model was such that targeted sheep producers would fatten their animals and pooling them for finishing and auction at a predetermined period. Towards this, farmers pooled together 132 weaner rams for the fattening pilot. Integration involved use of wheat straw as basal diet in sheep finishing rations. Participation

of the group in the sheep intervention were formalized through signing of contracts/farmer agreement forms. A 10 acre (4 ha) pilot feedlot communal plot was identified and planted with improved pasture. Further preparation of this plot for the finishing operation involved basic infrastructure development such as fencing and feed storage facilities.

The lambs in the feedlot achieved an average weight gain of 50g/day which was way below the expected growth rate of 200g/day. There is therefore a need to further validate and improve the technology (ration formulation, management, and breed) for finishing of weaner sheep on in Kenya.

Economic profitability of sheep fattening scheme was evaluated through estimating the expected cost benefit parameters (net present value (NPV), gross margin (GM), benefit cost ratio (BCR) and internal rate of return (IRR). The scenario whereby the farmers come together and contribute weaner lambs for fattening under feedlot system gave a positive NPV and GM and a CBR above one. This means that the costs invested in the lamb fattening scheme are recovered and high benefit realized. The discounted NPV was far above zero implying that it worthy investing in sheep lamb rams fattening for enhanced future benefit with a very high IRR of above 500%. In case where lambs for fattening are bought from the market, results showed that project will not be able to pay in the first season but the BCR above one in the second season implies that the model would be profitable from the second season and subsequently thereafter.

During the auction, traders preferred to negotiate prices based on live weight of the lambs rather than visual assessments common in livestock markets. This method of sale was acceptable to the sheep owners who appreciated that well finished lambs fetched better prices and higher incomes.

**TABLE OF CONTENTS** **Page**

## Contents


Executive summary ..... 2

1. Introduction ..... 7
2. Project site ..... 7
3. Problem statement ..... 8
4. Methodology and approach ..... 8
5. Outline of outputs, activities and achievements ..... 9

Output 5.1: Baselines conditions are established, ex-ante analysis conducted and R to B priorities for Best Bet elements of technological package options set up. ..... 9

Output 5.2: Identify/set up sheep and wheat R2B priorities and package best bet technological options ..... 23

Output 5.3. Undertake evaluation research activities to gauge applicability and adoption sheep and Wheat technologies/models ..... 25

Recommendations and way forward ..... 55

Output 5.4 Project coordination enhanced ..... 59

*Activity 5.4.1 Hold annual review and planning workshops* ..... 59

*Activity 5.4.2: Hold coordination meetings* ..... 59

*Activity 5.4.3 Monitoring of project activities* ..... 60

*Activity 5.4.4 Engage with partners to establish synergies and complementarities* ..... 60

*Activity 5.4.5 Monitoring of project progress* ..... 62

*Activity 5.4.6 Attend conferences (local and regional)* ..... 62

Appendix 1: Case studies of production costs associated with wheat farm operations for Nturumeti farmers participating in the Wheat R to B model. ..... 64

Appendix 2: Projected cash flow analysis of sheep R tom B fattening model – Scenario 1 ..... 69

Appendix 3: Projected cash flow analysis of sheep R tom B fattening model – Scenario 2 ..... 71

Table 1: Awareness on sheep production innovations - breeds and breeding management ..... 19
Table 2: Awareness on sheep production innovations - pasture and feed management ..... 19
Table 3: Awareness on sheep production innovations - feeds and feeding management ..... 20
Table 4: Wheat varieties distributed to farmers ..... 33
Table 5: List of farmers and varieties planted ..... 34
Table 6: Ram assignement to cluster groups ..... 36
Table 7: Profitability margins of different market innovations for wheat in Narok ..... 41
Table 8: Envisioned feeder route of Nturumeti livestock market, Narok ..... 43
Table 9: Costs associated with direct selling to millers at the NCPB ..... 48
Table 10: Comparison of helminth infection amongst the sheep at the day of introduction to the feedlot and at the day of auction ..... 52

Table 11: Body condition scoring in sheep ..... 53
Table 12: A comparison of the body condition scores and the mean live weights for the sheep at the feedlot ..... 54
Table 13: The comparison of body condition scores across breeds ..... 55
Table 14: Production norm for sheep fattening regime ..... 57
Table 15: Second Scenario (lambs from farmers own flock) - Cash Flow Analysis and projections for three years- Ram Fattening ..... 71

Figure 1. Narok country map ..... 8
Figure 2: Yield of performance of wheat varieties in Nturumeti ..... 47
Figure 3: Gross Margins with farmer practice and village storage ..... 48
Figure 4: Growth curve of feedlot sheep at Nturumeti ..... 50
Figure 5: Effect of time of castration on weight gain of weaner sheep ..... 51
Figure 6: A comparison of mean faecal egg counts (eggs per gram) for the different sheep breeds at Day) Day 84 and Day 99 ..... 52
Figure 7: Acomparison of body condition scores of weaner's sheep at the beginning and at the end of the fattening scheme ..... 54

# 1. Introduction

In May 2014, Kenya through KALRO was invited by ICARDA to be one of the six Nile Valley and sub-Saharan African countries to implement the second phase of the IFAD supported project *"improving integrated agricultural production systems for the poor and vulnerable communities in dry areas"*. Other countries are Sudan, Egypt, Yemen, Ethiopia and Eritrea. This was a two-year (2014-2016), low budget project (US$ 80,000 for Kenya) that was implemented on a yearly workplan and budget. The project goal was to enhance smallholder farmers' livelihoods in the Nile Valley and sub-Saharan Africa Region through innovative research to business (R2B) platforms

The specific project objectives were to

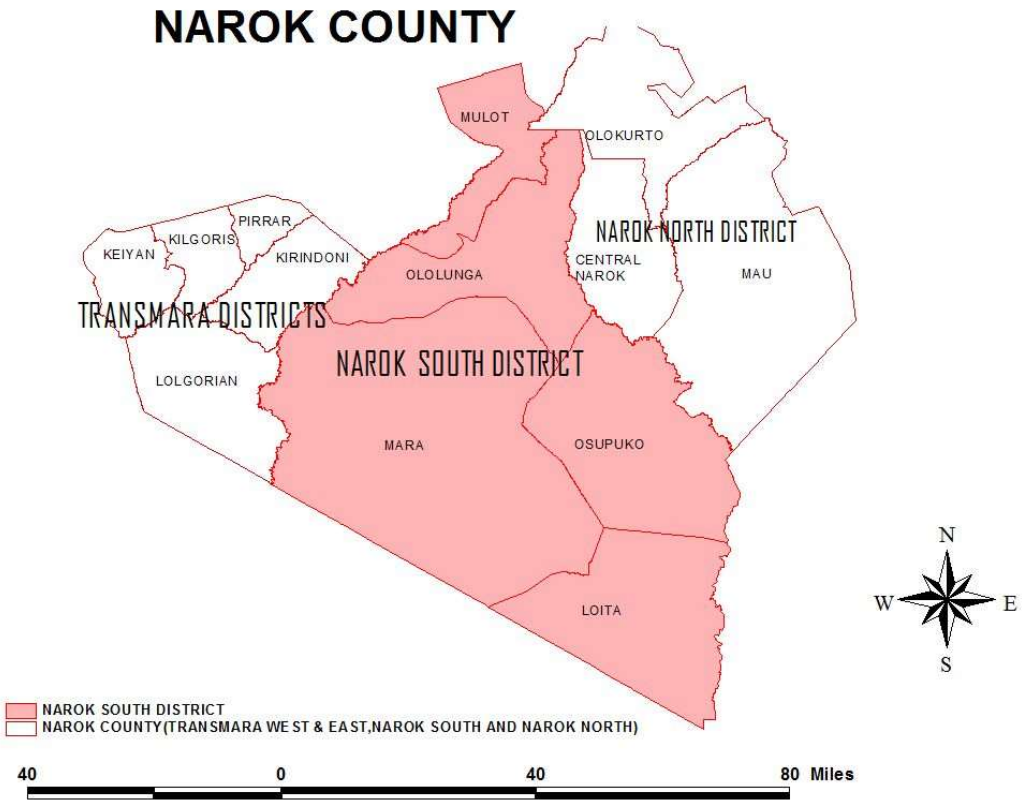
- Develop and validate profitable R to B models of tested and proven technology options
- Disseminate successfully tested R to B models

The project was the second phase and was aimed at validating and disseminating of the technologies developed in the first phase. Although Kenya was not involved in the first phase it was decided that it part of the second phase since it had mature technologies for dissemination.

# 2. Project site

In Kenya, the rainfed mixed sheep wheat production system in lower Narok was the designated country site. Narok County lies south west of Kenya and covers an area of 18,189 $km^2$ with only 8407 $km^2$ or 46% being arable (figure 1). It has human a population of 850,920 people (169,220 households). The county has both pastoral and crop farming communities spread within its five agro-ecological zones with livestock predominating in the lower zones and cropping in the upper zones. Mixed farming predominates in the midland semi-arid zones. Wheat is the major cash crop in Narok county and small ruminants account for the largest livestock population (sheep: 1,059,342; Goat 683,132). Thus community livelihoods in the semi-arid zone revolve mainly around mixed crop and livestock farming with a very low diversity of other income streams and hence placing inordinately high pressure on the land. Whereas Kenya has the potential for wheat production beyond the national requirements, realization of this potential is limited by several biophysical and social-economic factors. The average area under wheat production is about 140,000 Ha, whereas the potential is approximately 285,000 Ha (MoA, 2010). Average yield is 2-2.5ton per ha far below the potential of 4tons/ha. Consumption far outstrips demand with a 500 metric tonnes deficit met through imports (National Economic Review of Agriculture 2008-2009)

*Figure 1. Narok country map*




## 3. Problem statement

Smallholder wheat-sheep mixed farming systems in lower Narok- Kenya are characterised by low productivity and poor farm incomes. Challenges include adverse low and variable rainfall, high costs of inputs, lack of appropraite genotypes, pests and diseases, and lack of credit facilities, few storage facilities and poor marketing chnaels making farmers price takers at the mercy of middlemen. Additionally, farmers have limited access to improved crop and livestock husbandry skills and technologies, making them vulnerable to climate change impacts. Soils are very fragile and easily degraded, further limiting the ability of the land to support crops and livestock. Emerging threats linked to climate increasing frequency of long dry spells, unpredictable rainfall patterns, flash floods and emergent diseases.

## 4. Methodology and approach

The project involved testing of research-to-business model for wheat and sheep production based on a value chain approach and targeting 300 farm households.

a) Targeted wheat producers had access to improved technologies (varieties, agronomy) and knowledge to increase their yield. A menu of marketing options of improved wheat based on

empirical research and providing a comparative analysis among these options was tested and recommendation domains elaborated for wider adoption. These options include: 1) direct sale at farm gate to brokers, millers and other wheat dealers, 2) sale to buyers through the National Cereals and Produce Board, and 3) marketing through a common storage facility established in the village that relies less on middlemen thereby increasing incomes (warehouse receipting and contract farming).

b) Targeted sheep producers likewise had access to improved technologies and knowledge. The model was such that targeted sheep producers were fattening their animals and pooling them for finishing and auction at a predetermined period
c) Integration involved use of value added wheat straw as basal diet in sheep finishing rations and fertilization of wheat fields through sheep grazing and droppings as well as income exchange between the two enterprises

# 5. Outline of outputs, activities and achievements

## Output 5.1: Baselines conditions are established, ex-ante analysis conducted and R to B priorities for Best Bet elements of technological package options set up.

### *Activity 5.1.1 Consultative meeting on project inauguration and development of workplans*

A national consultative workshop was held for two days from 23rd to 24th June 2014 at KARI Muguga South Centre with the objective of preparing the workplans and budgets for 2014/15 year. The workshop was also used to bond with the project team members and familiarize the stakeholders with objectives of the IFAD-ICARDA phase II project. Sixteen participants attended the workshop, comprising of two extension officers and two farmers from proposed project action site of Narok County, three wheat research scientists from KARI Njoro, one scientist from KARI Molo, three range management researchers from KARI Kiboko, one animal health senior scientist from KARI Muguga North, two coordinators from KARI headquarters, one centre Director from KARI Kiboko and one animal specialist from ICARDA/ILRI in Addis Ababa office.

Presentations were given by invited participants as follows:

a) *Crop production systems in Narok County with special reference to wheat challenges and opportunities by County Director of Agriculture Mr Suji*

He gave county statistics as follows:
i. The county is composed of six sub counties which represent constituencies
ii. County area: 18,149.3 $km^2$ out of which 8,497 $km^2$ is arable and 2,304.43$km^2$ is medium potential where is good for pastoralism but leased out for wheat growing.
iii. Population: 850,920 people living in 169,220 house holds

Wheat production
i. Wheat growers lease land from pastoralists at KES 3000 to 4000 per acre per year to grow wheat. The action eats into grazing area thus endangering livelihoods of pastoralists who solely depend on livestock industry
ii. Large scale farmers produce 40% of wheat while the rest come from small scale farmers

iii. The yields per acre range from 5 to 15 bags and the break-even point is 8 bags per acre.
iv. That majority of wheat growers are not making money from the practice
v. Wheat growers mine the soils nutrients needing a county bye laws to protect the resource, otherwise the land fertility is rapidly going down with time.

Challenges
i. Conflicts between large scale farmers and pastoralists (loss of grazing land, restriction of mobility) among others
ii. Land degradation as a result of continuous nutrient mining of soils, soil erosion etc.
iii. Lack of policy to protect natural resources
iv. Limited extension staff to extend technologies
v. Wheat rust disease
vi. Migratory pests menace (Quellea birds)
vii. Poor access roads
viii. Limited value addition of crop products
ix. Frequent droughts

Opportunities
i. Unexploited vast land for wheat growing
ii. Favorable climate
iii. Existence of wheat stores to keep wheat
iv. Existence of subsidized fertilizers
v. Positive effects of devolution
vi. Rural electrification

*b) Livestock production systems in Narok County with special reference to sheep and goat challenges and opportunities by Principal Narok Pastoral Training Centre Mr. Francis Kunyanga*

County Statistics
i. Altitude ranges from 1000 to 4600m a.s.l
ii. Population of sheep is 1,059,342 while goats are 683,132
iii. Eighty (80%) of rural incomes is derived from livestock
iv. Pastoralism and agro-pastoralism production systems are practiced in lower zones and upper zones respectively
v. Wheat growers allow livestock to graze in harvested fields in the lower zones (wheat-livestock interface)
vi. Wildlife conservancies are found in lower zones but where only cattle are allowed to graze in them in cases of drought but not small stock (cattle wildlife interface)

Challenges
i. Cutting of tree forages for charcoal burning e.g. Acacia, balanites, olea trees among others
ii. Inappropriate land use system (cropping failures in lower zones, etc.)
iii. Decline in pasture production due to land degradation
iv. Soil erosion
v. Drought - leading to decline in pasture and water resources

vi. Lack of dry season grazing sites
vii. Land subdivision
viii. No value addition of livestock product
ix. Livestock pests and diseases
x. Marketing challenges

Opportunities

i. Narok county integrated development plan for five years (2013-17) is positive to livestock production
   - Livestock breed improvement
   - Disease control
   - Pasture development
   - Water harvesting and storage
   - Profit maximization
ii. Pasture harvesting machinery
iii. Training at NPTC
iv. Availability of Narok sheep and goats breeding station
v. Support from SLM project
vi. Community increasing uptake of pasture farming, storage and marketing

Desired status of sheep and goat sector in the Narok County

a. Increased per capita productivity for both land and livestock
b. Improved markets access
c. Sustainable use of NRM
d. Enhanced partnership among stakeholders in provision of services
e. Sustainable technology transfer mechanism
f. Reduced asset loss due to droughts

Proposed way forward

a. Utilization of opportunities listed above
b. Research on multipurpose trees, shrubs and pastures
c. Upscale pasture production and conservation strategies
d. Promotion and support to tree nurseries at the county to avail appropriate pasture plants species
e. Development of appropriate skills for harvesting locally available feed materials such as acacia pods, storing, processing and feeding
f. Promotion of elite breeders as sources of breeding stock
g. Development of livestock and their products promotion and value addition
h. Development of sustained programmes for livestock diseases and pest control

*c) Farmer's perspective Mr. Nickson Ole Kamoye*

In his presentation the farmer highlighted the following issues:

a) That diseases and pests for wheat farming was real in Narok County and called for KARI to assist
b) That the subsidized fertilizers by the government were too few to benefit wheat farmers
c) That KARI is unheard of in the county although it was handling crops and livestock issues in the county. He urged the institute to promote itself well like other ministries which are known

d) That KARI should be holding frequent field days in the county so that people can know its existence
e) That the county was losing trees through reckless cutting and asked KARI to promote afforestation of trees that benefit livestock and environment
f) That farmer's lack storage for farm produce

The farmer concluded by saying that the people of Narok County welcome any initiative that would better the livelihoods of its people

The PI on the wheat component made a presentation on proposals for up scaling of improved integrated wheat value chain technologies at the wheat livestock interface in Narok County Dr. Noting that Kenya produces 40% of the wheat it needs and 60% of that is produced in Narok County. He expounded on problems faced by wheat growers in the county and elaborated on the objectives of the wheat component and the proposed approach of R to B

The sheep component PI made a presentation on up-scaling of improved integrated small ruminant value chain technologies at wheat-livestock interface in Narok County noting that more than eighty percent of Kenya is ASAL where 70% of national herds are raised and pastoralism and agro-pastoralism production systems are practiced in Narok County. Additionally drought which negatively forage production is a big challenge in livestock production in ASAL. He elaborated on constraints and opportunities available for improving sheep framing and proposed the R to B approach for this to occur.
Constrains

The project coordinator gave presentation on system integration in agriculture noting that the system focuses less on technical fixes for discrete problems that affect food production by looking at challenges in a farm holistically and find fixes wholesomely. The farm is a basic integrated farming unit in which several farming systems operate which need to be approached in an ecosystem manner in solving problems.

He also gave a presentation on elements of work plan and Budget elaborating on the standard ICARDA-IFAD table for use in budget summary for activities was presented. The column side activities while rows contained elements. The table was to be filled in US dollars; however researchers were informed to use the standard KARI format which would be converted to ICARDA-IFAD format. Two groups were formed to discuss the presented proposals and enrich them while taking into consideration inputs from discussants..

Dr. Barbara Rischkowsky (htt://livestock-fish.wikispaces.com/UCD+Ethiopia) made a presentation on sheep and goats Development in Ethiopia. The presentation was done on the second day with a view to exposing some lessons learned from working on small stock research in Ethiopia. The presenter who is an employee of CGIAR centre has more than seven years of on livestock research in Africa and was at the time, attached to ICARDA-ILRI small stock project in Addis Ababa in Ethiopia.

**Activity 5.1.2 Selection of action sites**

A two-day workshop to revise and finalize the project concept and workplan was conducted at the Pastoral Training centre on 5th to 6th August 2014. During this workshop scientists were sensitized on principles of on-farm participatory action research by the National project Coordinator via PowerPoint presentation. Criteria for selection of sites were discussed and

agreed upon. Two sites were selected during field reconnaissance using objective criteria which included

- Accessibility
- Representativeness of agro-ecological zone
- Production system
- Scale of production
- Population density
- Nearness to markets
- Cooperativeness of farmers
- Potential to control or supervise action (presence of extension; community literacy level; security etc.
- Relevance of intended action to site

A total of 63 stakeholders were met and interviewed in focussed groups during the site selection process. Sites selected were Nturumeti and Olulunga and Narok County

Plate 1. Consultation with framers during site selection visit to Nturumeti.

*Activity: 5.1.3 Develop/adapt baseline survey instruments and pre-test questionnaire*

- The baseline survey tool was developed and pretested in one of the selected sites (Nturumeti) by a team of three scientists in the month of October 2014. The questionnaire was revised to structured format.
- During the pretesting , 17 farmers,( 3 ladies and 13 men) were interviewed in FGD

Some key highlights of the FDG from Nturumeti Village are:

- ✓ The farmers in the area practiced mixed farming, growing maize and wheat as well as rearing sheep and cattle. On average, farm sizes ranged from 15 to 100 acres and crops occupied approximately 80% and livestock 20% of the land. Out of the crop land, approximately 50% is allocated to wheat farming.

- ✓ In wheat farming, the following challenges were identified:
    - Diseases and pests
    - Bad weather conditions
    - Land degradation due to soil erosion
- ✓ The following were identified as the most popular wheat varies in the area, in order of popularity:
    - *Njoro 2*: This has been the most preferred over the last two years. It was reported to do well even when the rains were poor and also had heavier grains.
    - *Robin*: this was reported to have heavy grains and gave good yields when rains are good.
    - *Eagle 10*: good but needs good rains
    - *Kwale*: early maturing but prone to diseases
    - *Mwamba*: this was reported to have good yields but suffered from rust.
- ✓ Among the disease and pests, the following were ranked as the most:
    - Yellow rust
    - Stem rust
    - Aphids
    - Cutworm
- ✓ In sheep farming, the following were ranked as the main challenges:
    - Diseases
    - Feed shortage
    - Markets
- ✓ Among the sheep diseases, the following were ranked as the most important:
    - PPR
    - Heartwater
    - Foot rot
    - Diarrhoea
    - Helminth infections
    - In-breeding: this was noted during the discussions as the farmers were not aware of the problem
- ✓ It was observed that the flock sizes in the area varied widely, ranging from 70 to 1,200 sheep per household. Almost all of them were crosses between the local Red Maasai and Dorper. The farmers reported that they no longer kept the pure local RM. In order to get responses on the costs of production, it was decided that where

the cost per animal could not be easily obtained, a cost for a flock of 100 sheep be used for a period of one year.

- ✓ Wheat and sheep farming was reported to be complimenting in most instances. Farmers reported that they usually sold sheep to buy inputs for wheat as well as using proceeds for wheat to buy inputs for sheep. Sheep also grazed on the wheat fields after harvesting.
- ✓ The areas of conflict included sheep staying and grazing on the wheat crop as well as sheep contributing to soil degradation in the wheat fields.

The farmers indicated their willingness to work with the team. They were ready to partner with the research group and provide their farms and their flocks of sheep for the trials. The area chief requested that the community be given further trainings on soil and water conservation

*Activity: 5.1.4 Conduct survey in target community sites*

The baseline survey was conducted in the month of November 2014 in the two sites-Nturumeti and Olulunga. Four enumerators were recruited, trained and supervised to conduct the survey. A set of 32 households, 16 from each of the two sites, were interviewed. Four focused group discussions (FGD), 2 from each site, were conducted. Two key informant interviews were also conducted.

Plate 2. Training of enumerators at Narok Pastoral Areas Training Centre (NPATC) in Narok -November 2014

Plate 3. Sheep flocks in Narok County - November 2014.

Plate 4. Participants in the First, second and fourth FGD pose for a group photo

Plate 5. Participants in the third FGD pose for a group photo after the session

Plate 6. FGDs in progress in project sites in Narok County

Plate 7. Troughs used for mineral supplementation in Narok County

Plate 8. Supervisors countercheck data entry by enumerator in Olulunga and Nturumeti project sites in Narok County- November 2014

*Activity: 5.1.5 Analyse survey data (dis-aggregated by gender, farmer production system/practice categories) and write report*

A workshop was held in the month of December 2014 during which data entry template was developed and data entry conducted. Data cleaning and analysis was also done and report writing initiated.


Plate 9. Baseline survey data entry and analysis workshop in progress at NPATC in Narok

**a) Key findings of the baseline survey**

- Farmer to farmer learning was the most common way of accessing new technologies and information. However the information on marketing and new technology on sheep was not adequate.
- Surprisingly enough, all the respondents interviewed indicated that they have not received any formal training in sheep production. This was confirmed by their inability to classify the sheep breeds currently produced in Narok area.
- Sheep are naturally grazed in less improved pastures in Narok. As result, all the respondents reported to experience feed shortages particularly during the dry season. However, only 20% of respondents could conserve the surplus forage available during the wet season. The major feed shortage copping strategy) was by practicing pastoralism (75%) and use of purchased forages (13%). There was very low usage of wheat straw **(**3%)
- Wheat straw left after harvesting is used to support the sheep enterprise. The farmers reported the different ways in which they utilized the wheat straw. Majority of the farmers left the wheat straw in the fields either for animals to eat directly or used it as mulch. Few baled it for use as hay and some sale it outside the farm. There was no treatment to increase digestibility of the straw
- The survey revealed that farmers are faced with various challenges in marketing their livestock that include poor market prices, exploitation by brokers and poor infrastructure facilities. These challenges are compounded by lack of market information, delay in payment by KMC and lack of breeding technology leading to waste and poor returns on investment value.
- The study revealed that there are very few groups in the area that help farmers realize better return in sheep production. Only 16% of the household sampled reported being aware of such groups.
- Awareness about new innovations in sheep production, however level of adoption was relatively high ( table 1a,b,c)

*Table 1: Awareness on sheep production innovations - breeds and breeding management*

| Innovation | Awareness - % respondents | Source of innovation - % respondents | Adoption level - % respondents |
|---|---|---|---|
| Improved genetics | 31 | Fellow farmers - 68<br>Extension -22<br>NGOs -11 | 88 |
| Ram sharing | 13 | Fellow farmer-100 | 100 |
| Castration of culled rams | 37 | Fellow farmers -50<br>NGOs -50 | 50 |

*Table 2: Awareness on sheep production innovations - pasture and feed management*

| Innovation | Awareness - % respondents | Source of innovation - % respondents | Adoption level - % respondents |
|---|---|---|---|
| Weed management | 11 | Fellow farmers - 67<br>NGO - 33 | 100 |
| Baled hay | 28 | Fellow farmers- 38<br>Extension - 38<br>NGO - 25 | 38<br>38 |
| Standing hay | 21 | Fellow farmers - 40<br>Extension -20<br>NGOs - 40 | 50 |

*Table 3: Awareness on sheep production innovations - feeds and feeding management*

| Innovation | Awareness - % respondents | Source of innovation - % respondents | Adoption (% respondents) |
|---|---|---|---|
| Mineral supplementation | 17 | Fellow farmers – 50<br>Extension - 50 | 80 |
| Wheat straw feeding | 17 | Fellow farmers - 80<br>Extension - 20 | 60 |
| Hay feeding | 15 | Fellow farmers - 25<br>Extension -50<br>NGO - 25 | 50 |
| Use of commercial feeds | 8 | Fellow farmers -50<br>Extension -50 | 50 |

- From the questionnaire administered in the target area only 14% of the household indicated having received assistance in accessing market, production inputs (e.g. drugs, supplements and pasture seeds), veterinary services e.g. vaccination or disease control and financial services
- Decision on when to sell and what to sell was investigated and results analysed. Results showed that although men perform a major role in deciding when to sell, they involve their wives on decisions of what to sell.
- The Maasai women retain primary responsibilities for sheep milking and utilization of the milk and marketing of surplus milk. They also do pen cleaning and assist in providing sick animals with water. In Maasai society, men supervise more than 60% of the entire sheep production enterprise.
- Although men decide on when and where to purchases and deploy of sheep production inputs, they do not make some decisions such as utilization of proceeds from the sale of sheep in isolation; other household members, particularly women are consulted.
- A proportion 48% of the farmers in both sites use certified seed followed by 36% who use both certified and recycled, few 16% recycle seed. Of the interviewed farmers majority 48% source seed from the stockists followed by 32% who source seed from fellow farmers. A few 10% plant from their own seed. There are instances where farmers recycle seed with 59% recycling once followed by 34% who recycle seed twice with a few 7% recycling more than two times
- Wheat marketing has remained complicated with very many players, brokers and middlemen taking a greater share of it all.
- From the findings it was noted that 31% of the farmers sell their wheat at the farm gate followed by 28 % who sell to brokers. Twenty five percent sell to the national cereals and produce Board (NCPB) the rest 16 % sell to the middlemen. It was noted that farmers still

sell wheat at the farm gate due to poor post-harvest handling techniques, lack of machines and other commitments which urgently require cash.

- It is noted that small scale wheat farmers sell their wheat immediately after harvest. While this lowers the storage costs, it weakens the small scale farmers marketing leverage (hence receiving low prices).
- Small scale farmers in both Narok South have not been accessing information. From the interviewed households it was however noted that a proportion of 86 % of the farmers in Narok East had access to new wheat technologies with a smaller proportion of 14% stating to have no access. Their counterparts in Narok south had no access 100% to new wheat technologies. It can be concluded that the Narok south cluster was not in partnership with any organization dealing with wheat unlike their counterparts in Narok East cluster.

b) Recommendations from the baseline survey

Sheep keepers in Narok can benefit from capacity building in a variety of areas. From the baseline study it was evident that there have not been any opportunity for capacity building in sheep husbandry. The limited opportunities only existed for knowledge sharing amongst farmers themselves. Among the areas identified for capacity building include better husbandry practices, including cost-effective helminth control practices, better breeding practices that reduce the threat of in-breeding (castration of male culls, ram sharing, etc.) and for faster growth and high milk production, record keeping as well as feed conservation (especially with regard to enhanced utilization of wheat straw). Markets and marketing strategies that enabled sheep farmers to reap maximum benefits for the enterprise are also recommended. Finishing sheep by fattening is weak albeit the readily available and unmet market for mutton. Wheat straw can enhance the fattening strategy since is readily available in most parts of the county. The identified areas for capacity building can form a good entry point for the ICARDA project in Narok County.

The wheat farmers in Narok can improve their productivity by provision of capacity building support in some of the area identified in the baseline survey. Among these areas are wheat variety selection for high yielding qualities, early maturing and disease and pest tolerance, usage of fertilizer, especially top dressing (whose usage was reported to be low) as well as soil management practices to check land degradation. Marketing strategies that guarantee wheat farmers maximum returns should also be considered. Packaging and dissemination of available new technologies for both wheat and sheep enterprises can help improve access by the farmers. A hand book on wheat and sheep husbandry as well as production of brochures with specific aspects of the technologies are some of the recommended ways of improving access. These could be in addition to other methods of information dissemination during the lifespan of the project. These include farmer field days, field demonstrations as well as other organized farmers trainings

*Activity: 5.1.6 Hold inception workshop to sensitize stakeholders and present results of baseline survey*

A one day inception workshop was held at KALRO Muguga centre on 20th January 2015 and attended by 22 stakeholders including farmers. The implementation protocol was discussed and action sites/points agreed upon. The workshop was also attended by ICARDA NVSARP Regional Coordinator Dr Marwan Owaygen. Results of the baseline survey was presented to the stakeholders and discussed and R to B model was elaborated within a value chain framework focusing on:

a) Productivity improvement of wheat through adoption of high yielding, drought tolerant and disease resistance varieties and marketing in a warehouse receipting framework

b) Productivity improvement of meat sheep through fattening of weaners, use of fast growing Dorper breeds, husbandry and marketing through auctions.

The team identified the following technologies to be prioritized and validated technically and economically during year 1:

- Improved wheat varieties and agronomic practices in mixed wheat-sheep system
- Improved sheep production in mixed wheat system – strategic deworming, supplemental feeding for lamb finishing, improved breeds and breeding management for mutton


Plate 10. Participants of inception workshop pose for a group photo – January 2015

Plate 11. Dr Owaygen addressing participants at the inception workshop in Nairobi, Kenya

## Output 5.2: Identify/set up sheep and wheat R2B priorities and package best bet technological options

*Activity: 5.2.1 Desk top research to identify priorities, establish economic viability and commercial models for adoption of the technological options for improvement of small ruminant value chain (pre-screening of technologies and R to B options)*

- The team identified the following technologies to be prioritized and validated technically and economically
    - Improved wheat varieties and agronomic practices in mixed wheat-sheep system
    - Improved sheep production in mixed wheat system – strategic deworming, supplemental feeding for lamb finishing, improved breeds and breeding management for mutton
- Technical and financial feasibility was established awaiting validation
    - Cost and benefit associated with sheep production and marketing were evaluated through estimating the expected net present value (NPV), gross margin (GM) and cost benefit ratio (CBR). Based on these cost benefit parameters, a positive NPV and GM and a CBR above one was reported indicating that the costs invested in the sheep production are recovered and high benefit realized. The discounted net benefit was far above zero implying that it worthy investing in sheep production for enhanced future benefit. In addition, a sensitivity analysis was conducted. An increase in price of sheep through strategic fattening technologies, breed and breeding programme and collective marketing bargaining approach would enhance the profitability of the enterprise. Equally a better result would be realized through the reduction of production costs through strategic deworming regime and proper utilization of wheat straws. A combination of the two scenario would improve the profit of a small scale farmers by a greater margin. Deworming can increase productivity by up to 140% The current deworming regime is four times per year; proposed deworming regime:- Three times; Targeted pre/post mortality rate of 10% and a zero weight loss. Return of 215-248%
    - It was noted that wheat farming can be profitable using the appropriate varieties and management practices. For example, variety Eagle 10 remained the most profitable followed by Robin with (CBR) above 1. Kwale remained the most unprofitable variety having negative Gross Margins (GM's).
- The R to B model for sheep
  The components of sheep R to B model for sheep were developed in a participatory way with farmers. These are:
    - Promote onfarm finishing (fattening) of 200 dorper lambs of 4 months (22kg body weight) within 3 months by raising on grass supplemented with mineral, wheat

straw and a protein concentrate by targeting the lambs to add 200g/per day/animal. Note : Ration: {Chloris gayana/Boma Rhodes}+mineral+wheat straw with molasses +protein supplemenation

- Promote appropriate sheep routine management practices: (crossbreeding RM with dorper sires, disease control, record keeping, housing and cleaning, watering etc) and forage production,
- Strategic deworming (targeted deworming for fattening herd: deworm before entering feedlot, then onset of dry season and then 3wks into the rain season)
    - In general flock: deworm in march, then in May, thereafter in August.
    - Establish wheat (Variety Eagle 10) + pastures in march/april 2015,
    - Harvest material in july and bale
    - Allow one season of reseeding, spray broad leafed weeds
    - Type/form of Feedlot: (fenced area of 10 acres)
    - The group to take charge of both herding and security costs of the feedlot.
- Feedlot finishing of eweaner lambs.
- Use auction as an inovative marketing platform for better prices.

- R 2 B model for Wheat

The intervention targeted two sites (Nturumeti and Olulunga). The components of the R 2 B model for wheat were elaborated and agreed upon in a participatory way with farmers as described below:

- **Increase wheat productivity** from 2.5 tons per ha to 4.0 tons by introducing better yielding varieties and management package
    - On farm production through farmer participatory procedure
    - Suitable variety selection in different farmers' fields
    - Promoting access to certified seed
    - Train farmers on the management practices
    - Train farmers on the marketing strategies
    - Market innovation platforms
    - At least 20 farmers/farmer groups per site
    - Each farmer/group to have at least 2 acres of land
    - Farmer/group to be willing to
        - Provide the land
        - Provide inputs
        - Manage the crop as guided by the scientists and extension staff

- **Innovative marketing options**

A menu of marketing options of improved wheat were identified for testing and validation with 20 members of a local CBO. These options include: 1) direct sale at farm gate to brokers, millers and other wheat dealers, 2) sale to buyers through the National Cereals and Produce Board, and 3) marketing through a common storage facility established in the village. This latter option was emphasized by farmers during the stakeholder meetings. A feasibility study for this option will conducted to identify a funding mechanism for its establishment which may include a part of farmers' profit from the marketing of improved wheat and fattened sheep. The potential role of this community-based organization in facilitating the different marketing options of wheat will be investigated as an output of the project. The best bet options will be disseminated to 300 farmers within the area.

*Activity: 5.2.2 Hold workshop meetings with participating farmers and relevant stakeholders to develop and agree on R to B models/priorities (based on constraint/opportunity analysis, baseline data etc.)*

- Farmers and stakeholders discussed the R and B model in an inception workshop involving 22 stakeholders on 20th January 2015.
- R to B model was elaborated within a value chain framework focusing on:
  - productivity improvement of wheat through adoption of high yielding, drought tolerant and disease resistance varieties and testing of an array of marketing options
  - Productivity improvement of meat sheep through fattening of weaners, use of fast growing Dorper breeds, husbandry and marketing through auctions.

This model was further discussed and agreed upon with a wider farmer community in the target areas during the farmer recruitment exercise immediately after the inception workshop.

Output 5.3. Undertake evaluation research activities to gauge applicability and adoption characteristics associated with the Sheep and Wheat technologies/models

*Activity: 5.3.1 Design of the validation trials, select and organise participating farmers into groups and agree on implementation modalities*

**1.3.1.1 Sheep intervention:**

- Two meetings, one in Nturumeti and the other one in Olulunga, were held in February 2015. The relevant stakeholder, farmers and extension officer were in attendance. Pilot sites for the testing of the sheep improvement technology were agreed upon and implementation roadmap developed. Twenty (20) farmers belonging to a local community based organization (AFAPO) were selected and inducted into the validation pilot. Each farmer agreed to contribute 10 weaners to the sheep finishing pilot. The finishing pilot involved 132 lambs on a 10 acre plot belonging to a member of the farmer group. Additionally participating farmers were trained in innovation platform on new sheep and wheat husbandry practices

- The participation of farm group was formalized through signing of contracts/farmer agreement forms. These agreements spelt out the roles of each partner. Three contracts were developed for signing with the farmers;

  - Farmer receipt of grass seed- Rhodes/Boma – ICARDA Phase II project in Narok County

  - Farmer Receipt of Dorper Breeding Rams – ICARDA Phase II Project in Narok County Agreement Form

  - Farmer Collaboration/Donation of weaner lambs for feedlot fattening – ICARDA phase II project in Narok County Agreement Form

- The 10 acre (4 ha) pilot feedlot plot was ploughed, harrowed and planted on 16th April 2015- Boma Rhodes grass seed sown with wheat (Variety- Njoro II BW)

- A series of activities lead to the establishment of the feedlot- trial of sheep model. Routine monitoring of the two plot, feedlot and the seed bulking was done.

**Selection of weaner lambs for feedlot fattening**

- Exercise aimed at identifying 200 Weaner male lambs for feedlot finishing from flocks of participating farmers.
- The work started in the week of 2-7 Nov 2015 – 88 weaners were selected
- Phase II: week of 14-18 Dec 2015- 44 lambs selected. During the selection, data on lamb identity, farm name, and sheep husbandry practice and disease control were recorded.

Plate 12. Pastoralists sorting sheep to identify lambs for the feedlot exercise

Plate 13: Lamb ID- Ear tagging

Plate 14: Blood sampling - PCV

Plate 15: Faecal sampling – per rectum

**Feedlot finishing of weaner lambs**

The trial began on 17th Dec 2015 with 132 male lambs approximately 4 months old. Lambs were recorded, weighed, castrated, dewormed and applied with broad-spectrum ectoparasite control agent (pour on) before entering the trial.

Plate 16: Lamb in the feedlot

Plate 17: Lambs being weighed

Plate 18: Lambs being castrated

Plate 19: Lambs being drenched

Plate 20: Applying ectoparasite control agent on lambs

**Feeding/Nutrition procedure, Nturumeti experiment**

1. Grazing daily for 8 hours
2. Wheat straw 22kg/132 sheep
3. Lucerne hay 11kg/132 sheep
4. Molasses 6kg/132 sheep
5. Mineral salt, balanced commercial preparation 30g/day/sheep
6. Watering every other day from a nearby pond

Later at day 84 introduced

1. Beef maclick salt – 30g/day
2. Pig finisher, commercial energy concentrate- 50g/animal/day

Management

1. All sheep dewormed on day zero
2. External parasite control- pour on, 1 ml/10 kg body weight
3. Sheep penned at night-open enclosure
4. Vaccinated against sheep pox on notification (in February ) and blue tongue on notification (early march)
5. Sick sheep treated promptly

The lambs were allowed to freely graze on the herbage in the feedlot for 8 hours per day. Later, they were allowed to a supplement mixture consisting of of wheat straw, lucerne hay and molasses per day and allowed to lick on balanced mineral (vital kondoo) salt. They were allowed to access water every other day from a water pan locacted 300m from the feedlot facility. The feed ration of the sheep lambs was determined based on nutrient requirement as for growing weaner sheep.

Pilot flock: 132 castrates aged 4 months

The feedlot, 10 acres of fenced land, complete with a night shade and watering system, was planted with high quality forage grass, Boma Rhodes- *Chloris gayana* that was sown with wheat and manged as follows,

- Plan; establish wheat (Variety Njoro BW II) + pastures in 16th April 2015,
- Harvest material, wheat straw and rhodes grass, in August 2015, bale and conserve.
- Allow regrowth period, 3months, of resting/reseeding.

The weaners, 132 castrates, contributed by 16 farmers belonging to AFAPO CBO based at Nturumenti sublocation of Ongata –Nadoo location, Narok East, Narok County.

d) Enter animals into feedlot in December 17th 2015 and rear them for the 3 months.

- Auction first lot by 11th of April 2016

Lambs were weighed every fortnight to determine growth rate. Sick cases were treated promptly. Lambs were vaccinated against sheep pox and blue tongue on the 28th and 84th days respectively.

Plate 20: Lambs feeding on supplement mixture

Plate 21: Lambs licking on mineral salt

Experiment commenced with 132 lambs, 6 lambs died in the course of the trial from bloat, sheep diseases-pox and blue tongue, complications arising from the feeding of molasses. Even though the trials was research lead, it was managed on day to day by the farmers. The farmers were involved in data recording and entirely supervised the feeding. A shepherd, paid for by the project, was looking at the lambs during the day while at night, a watchman, paid for by the CBO, and was guarding the animals and the facilities. The fattening period coincided with a heavy rainfall season that caused the flaring up of sheep viral conditions (sheep pox, blue tongue). Lack of technical supervision resulted in improper feeding of some feed ingredients such as molasses that farmers observed caused impaction at the colon leading to death. The manual chaff cutter was laborious for the pastoral community to use. This hampered the processing of the feed forages for the fattening sheep. The lambs were not screened for known antibodies prior to the fattening period which may have resulted into the recruitment of lambs incubating infectious diseases.

#### 5.3.1.2 Wheat intervention

34 pilot wheat farmers were provided with improved varieties to grow in a total of 68 acres (each framer planted 2 cares). A total of five different wheat varieties were distributed to the selected farmers ((table 2). These varieties included Kingbird, Wren, Hawk, Eagle 10, and Njoro 11. Planting was done in April 2015. Each of the varieties was allotted to the different farmers through balloting (picking of lots). And each farmer got same variety for the two acres (table 3).

Farmers agreed to cost share by taking the responsibility to meet the cost of land preparation, weeding and other agronomic practices required. The level of input supply was left to the discretion of each farmer after getting training on improved management practices. Below is a description of wheat varieties that were distributed to framers for planting.

Plate 22. Ploughed sheep finishing plot

Plate 23. Mechanized land preparation at Nturumeti project site- April


Plate 24. Mechanised seed drilling at Nturumeti project site – April

*Table 4: Wheat varieties distributed to farmers*

| Commercial Name | Altitude | Yield potential tons/Ha | Maturity period (days) | Special attribute | Notes |
|---|---|---|---|---|---|
| Kenya Wren | 1800-2400 | 8.5 | 120-130 | Has adult plant resistance to both yellow and stem rust diseases. Large red hard grain with excellent flour conversion, high protein content, good for home baking and *chapatis*. Resistant to both yellow and stem rust. Tolerant to acidic soils. | May grow tall under high nitrogen application |
| Eagle 10 | 1800-2100 | 6.5 | 100-110 | Good resistance to stem rust (Ug99 strain). Very early maturing hence suitable for drought prone areas like Mweiga, low Narok and Rongai. Long grained with high protein content of 13%. Very good baking quality. | Its earliness makes it ideal for off season crops. |
| Kenya Kingbird | 1800-2400 | 6.0 | 90-110 | Developed for Adult plant resistance to both stem rust and yellow rust. A good parent in breeding especially for rust diseases. White grain with very high test weight and flour conversion. | So far the best for Adult plant resistance for both stem rust and yellow rust. |
| Kenya Hawk | 2100-2400 | 8.0 | 120-130 | Red hard grain with resistance to both lodging and sprout. High test weight and baking qualities. May be good for areas that receive rain during harvesting like Mau Narok and Timau | |
| Njoro II | 2100-2400 | 8.0 | 140-160 | High yielding red wheat with resistance to acid soils. Suitable for Uasin Gishu, Molo and Trans-Nzoia. Resistant to lodging and sprouting. Good breed making quality. | Its high yields and resistance to sprout makes it very popular with farmers in the highlands. |

Out of the 14 farmers that had been targeted with the wheat intervention in Olulunga only 8 actually planted the seed. In Nturumeti 15 framers planted project seed as tabulated below. In total 23 farmers planted a total of 66 acres (table 3)

*Table 5: List of farmers and varieties planted*

Table 3. List of farmers and varieties planted

| Variety | No. of framers | Acreage (acres) |
|---|---|---|
| **Kingbird** | **4** | **8** |
| **Kenya Wren** | **4** | **9** |
| **Hawk** | **4** | **8** |
| **Eagle 10** | **6** | **15** |
| **Njoro 2** | **2** | **4** |
| **Total** | **20** | 44 |
| | **Pasture feedlot plot** | 10 |
| | Pasture demonstration plot | 2 |
| Grand total | | **66** |

*Activity: 5.3.2 Train organised groups on technological packages (specifics, strategic deworming, housing, sheep calendar, feed processing and conservation)*

### Sheep component

To facilitate adoption of improved sheep and wheat R to B model 22 participating farmers (5 women and 17 men) of a local community based organisation (AFAPO) were trained on pasture establishment, improved sheep and wheat management technologies. A two acre plot was planted with Boma Rhodes grass. The plot will serve as a demonstration site and a seed bulking site for forage grass- Rhodes. The harvested grass seed will be shared out with community members. However, farmers will pay a nominal fee for accessing the grass seed.

Plate 25. Training participants at Nturumeti centre- July 2015

The following training topics were covered:

a) Ram use and exchange programme: This session was led by Mr. Jackson Naikuni, the chair of AFAPO CBO. The group members discussed how the rams will be shared after the acclimatization period of two weeks. The programme was designed to get a group of 3-5 farmers share a ram and have these rams rotated amongst the groups after six months. The rams will be based in one *boma* with the farmers hosting them taking the responsibility for their security, proper feeding, vaccinations and any necessary treatments. They are also to ensure that the breeding ram was the only male in the flock. The mating ration will be 1:25 initially because the rams are young. The breeding ewes will be brought to the *boma* housing the ram and allowed to remain there for two months after which they will be rested for two weeks before resuming the mating with a new group of ewes. A fee of between KES 50 and KES 100 (to be agreed on by the members of the CBO) will be charged for each ewe mated so as to generate a kitty for supporting the provision of supplementary feeding for the rams and other operations like treatments and vaccinations. Proper records on the activities of each ram will be entered in the books provided, maintained by the farmer accommodating the rams. The rams were subsequently officially handed over to the group management committee from the project team at later session after the training meeting.

The rams were assigned to each of the seven group clusters of farmers as follows, respective group members are shown below (table 4):

*Table 6: Ram assignment to cluster groups*

| Group cluster | Ram Ear tag number | Members of the cluster Group |
|---|---|---|
| 1 | S1727 | 7 |
| 2 | S1557 | 4 |
| 3 | GF0175 | 2 |
| 4 | S1523 | 6 |
| 5 | S1555 | 1 |
| 6 | S1539 | 5 |
| 7 | S1520 | 3 |

b) Elements of a sheep management calendar: The farmers were taken through the concept of developing a sheep management calendar. A draft calendar based on the planned mating of ewes in August was made during the session. Some key management activities, including enhanced feeding of breeding ewes, deworming, vaccinations, lambing were included in the calendar.

c) Routine sheep data and recording: The farmers were explained the importance of record keeping and later taken through the key records that they require to record and maintain for the sheep enterprise by the PI of the sheep component of the project. The requisite data collection schedule for simple farm breeding data was circulated and discussed by the PI and adopted by the farmers.

d) Strategic deworming: The farmers were shown the different types of helminths that infect sheep as well as the different families of dewormers and how to prudently use them. They were then taken through the principles of strategic deworming. It was agreed that three treatments will be adequate: three weeks after onset of long rains, shortly after onset of dry season and three weeks after onset of short rains. Individual animal treatments can be given to any sheep that showed signs of helminth infection.

e) Contracts with participating farmers: Farmers were taken through the three contracts (receipt of Rhodes grass seeds, Receipt of the six Dorper breeding rams and contribution of weaner lambs for fattening). Each of them was explained to them, with amendments being inserted when this was found necessary. Some of the issues that came up during this session included:

- Farmers enquired on the duration of the project so that the information can be included in the contracts. The project coordinator explained that the project was a two year activity. The first year is ending and now getting to the second year. Year two will concentrate on upscaling to other areas if the model proved successful. The end of the fattening and auction of the sheep will mark the end of the contract with AFAPO CBO.
- The criteria for animals to be admitted to the feedlot will be agreed between the farmers and the project as well as the mode of payments by those who will be buying the sheep at the auction.

### Wheat management and husbandry

Before planting and at the time of distribution of seed framers were trained on all aspects of wheat agronomic practices, including land preparation, timely planting, weeding, fertilizer application and harvesting. A total of 34 framers were trained.

**Activity: 5.3.3 Facilitate farmer access to quality inputs and genotypes (including purchase of demonstration materials/animals)-how many to buy and how to use**

#### *Sheep improvement*

Seven pedigree Dorper breeding rams (average weight 49kg at 1yr 2months age)) bought by the project and selected by the farmers were handed over to the AFAPO CBO. These sheep were bought from Gicheha Farm in Ruiru. The CBO representatives were at hand to select the sheep and be taken through management tips. Of the seven sheep, one was bought with contribution of the farmer group. Dorpers are essentially bred for meat. The rams will be cross-bred with local Maasai sheep to improve the growth rate and meat qualities of the local sheep thereby fetching a better price in the market. The rams will be used on a rotation basis within the seven clusters identified by the farmers - in a "hand-mating" breeding design developed by the project. It was agreed that the group will charge a fee for each ewe mated thereby ensuring revolving fund proceeds which will go into maintenance of the rams. This will ensure sustainability of the venture. To help them acclimatize, the rams were weighed, dewormed and a broad-spectrum antibiotic administered before the handover. The rams will be allowed 21 days acclimatization period before any breeding begins. A simple farmer friendly data collection protocol has been developed to monitor performance of the rams. The concept is to get progeny that will efficiently respond to improved management (fattening) thereby increase profitability of the sheep enterprise and farmer incomes.

The rams were officially handed over to AFAPO CBO members by the national project coordinator. This ceremony was attended by the members, KALRO scientists, extension and the location chief. Prior to this, the farmers were shown how to weigh the sheep by demonstrating with breeding rams. Prior to handover to framers, the rams treated with a 20% long acting oxytetracycline (Alamycin® 200, Norbrook) and a 10% albendazole (Valbazen® 10%, Ultra vetis) to cover them from stress and related illness.

Plate 26. Handover of pedigree Dorper rams

Plate 27. The rams were bought from a reputable commercial sheep breeding farm, Gicheha farm in Ruiru, Kiambu County.

The rams are routinely weighed – fortnightly – in order to monitor their performance as shown below.

| Parameter | mean | Range |
|---|---|---|
| Avg age July 2015(mo) | 15.4 | 15 - 16 |
| Avg wean wt (kg) | 29.3 | 29 - 29.4 |
| Avg wt (kg) 8th july | 47.4 | 43 – 51 |
| Avg wt (kg) 23th july | 48.6 | 44 – 53 |
| Avg wt (kg) 6th Aug | 49.1 | 42 – 54.5 |

An elaborate ram exchange schedule has been developed together with farmers.

#### 5.3.3.2 Wheat improvement component

A total of 78 bags of wheat seed were distributed to the farmers. Each of the farmers was to receive two bags of the varieties distributed after training and balloting for the variety to be grown. 100% of wheat distributed to farmers in Nturumeti was planted however a few cases of farmers not planting the seed in Ololulunga were reported. Of the cited reasons was that the seed was delivered when the planting season was over which a fact disputed by their counterparts. Participating farmers agreed to meet their cost of ploughing, planting, fertilizer application, weeding and harvesting operations.

### *Activity: 5.3.4 Hold field days for technology demonstrations*

#### Sheep component

Demonstrations on sheep weighing, sheep drenching and dosage determination was conducted in July 2015.

Plate 28. Demonstrations on sheep weighing in project site- Nturumeti- July 2015

### Wheat component

One field day was held in Nturumeti on July 10th 2015 where all the wheat varieties recommended for dry areas were showcased by under ICARDA /ADB project. During the field day farmers were able to select varieties which they felt could best suit their conditions.

*Activity: 5.3.5 Link farmers to markets and service providers including financial services-marketing, advertise, workshops, actual auction.*

#### 5.3.5.1 Wheat R to B platforms

A market innovation platform was held at the Narok pastoral training centre. The platform involved County MOA officials, farmer representatives from project sites and a cereal trader. The wheat millers and NCPB had been invited but did not attend.

a) Variety assessment (Farmer perceptions)

Farmers gave their comparative assessment of the wheat varieties that they had been given by the project to pilot as shown below

Table 5: Farmer assessment of performance of wheat varieties

| Variety | Assessment |
|---|---|
| Wren | Slow maturing |
| | Germination was not very good |
| | Susceptible to rust |
| Hawk | Slow maturing |
| | Does require high amounts of moisture in the soil at the time of planting |
| | Signs of tolerance to rust infestation |
| Njoro II | Susceptible to both yellow rust ant stem rust |
| | Slow maturing |
| Eagle 10 | Requires high doses of P ( some farmers were forced to apply 75 Kg per ha of DAP) |
| | Less susceptible to rusts |
| | Fast maturity |
| | Ideal for drier zones |
| Kingbird | Fast maturing |
| | Susceptible to cold |
| | Seems more productive; more filling of the grain |

Overall the farmers recommended Eagle 10 and Kingbird as the most suitable for their region. However yield potentials of the different varieties are to be validated after harvest. Njoro II was the least preferred by farmers. Farmers expected to harvest 22-40bags per acre in the current season.

b) Marketing

Farmers were reminded about the objective of the project which was to achieve a better profit on a sustainable marketing platform. They were reminded of the options thus:

- **Scenario A (Warehouse receipting)** - where NCPB buys the wheat and provides a receipt which farmers can use to redeem their money from a bank. This idea was discussed but farmers felt that NCPB could not be trusted. It was also noted that the warehouse receipting innovation currently applies to Maize and not wheat. The NCPB officials were also not present to present their case.
- **Scenario B:** A contract with millers so that farmers can enter into a contract with millers to buy their produce on agreeable terms. However there was no representation from millers and therefore this option could not be pursued further. It was also noted that millers operate through middlemen who source wheat from framers and deliver to the middle men.
- **Scenario C:** Contract with large scale grain handler and trader. Rupian Technologies LTD represented by Mr Sankei ole Kenga made presentation of their contract model to the platform. Their philosophy is "Farmer on Top – partnership with the farmer". They have experience in dealing with large scale grain purchase particularly maize; and are now set to venture into wheat. Their model is to overcome the situation where farmers are price takers due to their inability to organise themselves into marketing groups or cooperatives. Farmers would sign a contract to sell their wheat to the company. The company would aggregate wheat, store for a month or two and then then sell when prices are good. The profits would then be shared on 40 (farmer):60 (company) basis over and above an agreed minimum payment given to farmer at the time of sale. The company intends to include an input provision package during the next planting season. This solves the problem of farm-gate sales and leverage on bargaining power of numbers and volumes. He noted that Narok accounts for 80% of all wheat produced in Kenya.

- **Scenario D: Farmgate selling to middlemen**
- In this scenario farmers would continue with normal practice of individual selling to the highest bidder. Farmers felt that this system although somehow exploitative guarantees the farmer instant payment and is more reliable. Farmers lose up to 5 bags per acre in the measurement unit. The project economist provided profitability margins (table 6) for all these options to guide farmers in reaching an informed decision as shown in the table below.

*Table 7: Profitability margins of different market innovations for wheat in Narok*

| Scenario (option) | Minimum Production per acre (100kg-bags) | Price per bag (Kshs) | Total revenue per acre (Kshs) | Total Costs per acre (Kshs) | Profit (Kshs) | Comments |
|---|---|---|---|---|---|---|
| A | 15 | 3000 | 45,000 | 21495 | 23495 | |
| B | Not discussed | | | | | |
| C | 15 | 2400 | 36000 | 20830 | 15170 | Additional sharing of 40:60 profits over and above the selling price (about Kes 4500) per acre |
| D | 15 | 2500 | 37500 | 20830 | 16700 | |

Source: survey data

After lengthy deliberations

a. The farmers agreed to sale their wheat through a contract with Rupian technologies on mutually agreeable terms

b. The agreement must be reached within a time line agreed upon by the farmers otherwise they would individually sell their wheat to the highest bidder i.e. option D

c. This decision would be ratified by the large group of farmers

**Challenges**

Farmers were eager to retain their harvest of Eagle 10 and Kingbird as seed for the next year's crop

a. Farmers are under great pressure to sell the two varieties as seed at premium prices due high demand from other farmers. Already there many offers to buy the project produce.

b. Although farmers felt that Farmgate sales favour middlemen, they are however sceptical of other forms of market innovations such as contract farming and ware house receipting for a variety of reasons:

   - Late payments – which may put their loan repayments at risk
   - Fear corrupt tendencies in public grain handling agency
   - Feel the processes of drying, grading and transportation is tedious, inconveniencing and prefer to pass this cost to middlemen even if this eats into their profits
   - General lack of trust

c. Thus they prefer to sell at the farm gate. The profits are comparable to those in organised market innovations and is a time tested model which works

### 5.3.5.2 Sheep R to B platforms

The sheep component of the project facilitated the conducting of two open days. One major field day was held on the day of auction of finished sheep lambs on 11/4/2016 and attended by over 50 stakeholders (farmers, livestock traders, extension officers, abattoir/butchers, meat processors, scientists, donor representative, political leaders and local administration


Plate 29: *A visibility board (L) and participants (R) of open day/leaders consultative forum*

Another open day/leaders consultative forum was held on 8/4/2016 and attended by 19 stakeholders inclusive of 13 farmers. This forum was very important since the leaders developed the road map for establishment of a livestock auction yard at Nturumeti Centre. The ground work of market yard was laid out and the auction of the finished sheep lambs acted as the first market day of the envisioned livestock market yard. This was expected to be the outcome of the sheep value chain improvement activity at Nturumeti. Prior discussions with the AFAPO group members had indicated that the farmers required a livestock market at Nturumeti to enable them sell their livestock easily. The other markets are in Ntulele and Mosiro. The animals heading to these markets pass through the trial site and presence of a market locally would be beneficial to farmers and traders who currently use the other two markets.

An official from the Narok Livestock Traders Cooperative (NLTC), Mr Solomon, made a presentation on the different players involved in livestock markets. The players include the county government (represented by Veterinary department, revenue clerks), producers, traders (sellers and buyers) and brokers. Each market form a livestock market committee that oversees issues to do with security (including livestock thefts), market promotion, coordinating movement of livestock from one market to another, monitoring of data on livestock sales and addressing any disputes in the market.

It was reported by the area chief that a 15 acre piece of land existed approximately 5km from the trial site. The land was reserved for a market, water project and animal handling facilities. The envisioned market would have 9 feeder routes with an estimated 460 market sheep and goats.

*Table 8: Envisioned feeder route of Nturumeti livestock market, Narok*

| No | Name of feeder route/area | Estimated head of sheep and goats |
|---|---|---|
| 1 | Oloosokon | 50 |
| 2 | Ongata-Nadoo | 100 |
| 3 | Tikako | 30 |
| 4 | Enoobarbali | 50 |
| 5 | Enoolpopong | 60 |
| 6 | Kormoto | 30 |
| 7 | Makutano | 100 |
| 8 | Ooolturot | 20 |
| 9 | Nturumenti | 100 |

The meeting agreed on the way forward as follows:

1. The farmers will approach the county government for lobbying/approval to establish a livestock market in the area.
2. The sub-county livestock officer in collaboration with the chief to develop a proposal on the same and present it to the county livestock officers for further action.
3. The stakeholder involvement in this process was acknowledged and it was agreed to include the county government (approval, design), NLTC, NEMA (to carry out environmental impact assessment), area leadership (chief, member of county assembly -MCA) and the CBO (AFAPO and others).
4. The proposed market day was agreed to be Monday. This was because the other nearby markets are held on Tuesday and Wednesday and any animals not sold at Nturumeti could be taken to these other markets.

The proposal was presented to the area political leadership and other county government officials during the auction for discussion

The auction day started with putting the sheep into the designed lots and cubicles by the farmers followed by verification by the project team. This took place as the meeting venue was being prepared and arrival of the invited guests. The guests included the chief guest, county director of livestock and fisheries, Dr Mpilei, (representing the CEC, Agriculture, livestock and fisheries), county director of veterinary services, Principal, Narok pastoral areas training Centre, Mr Miaron - official representing KMC, Sub-county livestock officer, MCA for Mosiro ward and Director ARLRI, Dr. W. N. Mnene.

Plate 30: Project team verifying the sheep ID and numbers (L) and guests settling for the meeting (R)

The order of activities preceding the auction were as follows:

- Viewing of the feedlot structures and lambs: the guests were taken through the structures (feedlot plot, feeds store) and shown the animals inside the cubicles. A briefing on the project activities was made to the guests by Dr. Nginyi.
- Remarks by the AFAPO CBO chairman: he reported on the benefits the group has received from the project since inception, including training, provision of breeding Dorper rams, pasture establishment and the feedlot.
- Remarks by the chief, Ongata-Nadoo location
- Remarks by the MCA, Mosiro ward: he appreciated the contribution the project made to the participating farmers and expressed the desire to see farmers in the area adopting the new knowledge given by the project. He supported the idea of establishing a livestock market in the area, saying it will help other businesses to grow and shopping centres to improve. He urged the farmers to adopt livestock farming as a business rather than a cultural activity. He warmed them against indiscriminate use of veterinary drugs and consumption of dead animals even after the same have been treated.
- Remarks by the sheep component PI.
- Remarks by the NPC.
- Remarks by the Director, ARLRI (representing the DG, KALRO)
- Remarks by the chief guest (County Director, Agriculture, livestock and fisheries, representing the CEC) and launch of the auction

Plate 31. The AFAPO vice chair (L), Sheep component PI (middle) and the NPC address the farmers and guests

*Activity: 5.3.6 Data collection, analysis and Results*

### 5.3.6.1 Wheat improvement component validation

Data collected included yield and yield components to establish the profitability of the wheat enterprise. Selling points for the farmers were established and it was noted that most of the farmers 98% sold wheat at the farm gate to the ever exploiting middlemen/ brokers. The rest 2% sold to NCPB and millers. Wheat was mainly sold as Grain with few of the farmers selling it as seed to fellow farmers. Possibility of village storage facility was explored, this facility could also serve as the village selling point (VSP) for wheat in the future. This would reduce on costs of transportation and other related costs when wheat is taken to the available stores. Profit margins for the farmers would also improve thereby making wheat a more profitable enterprise.

#### 5.3.6.1.1 Results of Wheat R to B model validation

#### 5.3.6.1.1 .1 Variety performance and ranking

**Kenya Wren**

Variety Kenya wren was planted by two farmers in Nturumeti, and ranked highest amongst all the 5 varieties planted at 2.5 T/ha which is within the national average of 2 to 2.5 Tonnes (Figure 2) .This production was consistent with the farmer assessment of the variety during growth period. Farmers noted that the variety had the following attributes:

- Good germination
- High tillering ability
- Disease tolerant particularly to stem rust
- Large grains and high bushel weight
- High demand on the market

Farmer's assessment confers with the breeder's description of the variety showing that it is suitable for growing in lower Narok (Nturumeti target area).

Varieties Eagle 10 and hawk were the second highest yielders in the target area with a mean yield of 2 tonne/Ha each respectively.

**Eagle 10**

Variety eagle 10 was planted by 5 farmers and ranked second amongst of the five varieties with average production of 2 tonnes/ha which was within the national average production 2 to2.5 tonnes/ha .Production of Eagle 10 was consistent with the farmer assessment of the variety during growth period. Farmers noted that the variety eagle 10 had the following attributes:

- Dense Root mass of about 98%
- Good Germination (95%)
- Good tillering ability
- Early maturity – which is ideal for dry zones as pertains to lower Narok
- Less susceptible to rust

Farmers' assessment confers with the breeder's description of the variety showing that it is suitable for growing in lower Narok (Nturumeti target area).

**Hawk**

Variety Hawk was planted by 3 farmers and ranked second amongst the five varieties with average production of 2 tonnes/ha which was within the national average production 2 to2.5 tonnes/ha .Production of Hawk was consistent with the farmer assessment of the variety during growth period. Two out of the three farmers that grew variety Hawk noted that it had the following attributes:

- High yielding
- Resistant to yellow rust
- High bushel weight

The assessment is not consistent with the yield parameters of this variety .Although the variety is recommended for high altitude areas results from this trial shows that it is suitable for lower Narok .The yield of hawk is comparable to that of Eagle 10.

**Kingbird**

Variety King Bird was planted by 2 farmers and ranked 4 amongst the five varieties with average production of 1.8 tonnes/ha which was below the national average production 2 to2.5 tonnes/ha .Production of Kingbird was inconsistent with the farmer assessment of the variety during growth period. Farmers noted that the variety Kingbird had the following attributes:

- Early maturing
- High Yielding
- Resistant to diseases

Farmer's assessment confers with the breeder's description .However the yield may have been affected by low/lack of rainfall during grain filling of the variety. Probably field trials need to be carried in regard to the suitability of the variety particularly for lower Narok.

**Robin**

Variety Robin was planted by the AFAPO group and ranked last amongst the five varieties with average production of 1.0 tonnes/ha which was far much below the national average production 2 to2.5 tonnes/ha. Until recently Robin was the most commonly grown variety in the target area. However it has developed susceptibility to rust diseases particularly Ug99 making it less productive and profitable due to high input requirements (e.g. Spraying three times with fungicides). Farmers noted that the variety Robin had the following attributes:-

- Susceptible to diseases
- Low bushel weight

Farmer's assessment confer with what is now known about the productivity and resistance of this variety to diseases.

**Njoro II**

Njoro II variety was planted by 2 farmers who were considered as outliers. Farmer one Ms. Nasieku low yield of 4 bags/acre (0.4 tonnes) was inconsistent with a production cost of Ksh. 18,950. This was attributed to the poor knowledge about inputs. She relied on an interpreter (fellow farmer) during the interview.

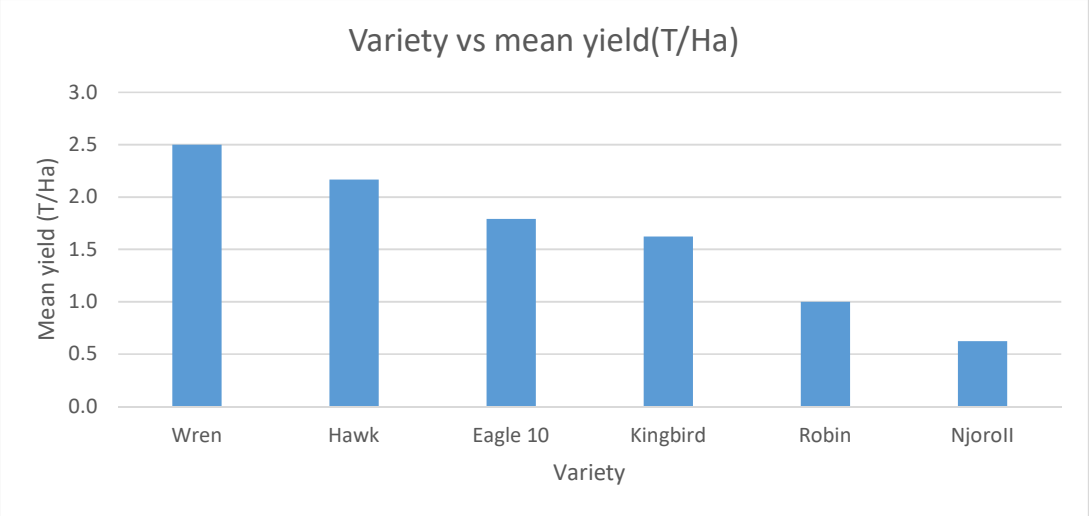



*Figure 2: Yield of performance of wheat varieties in Nturumeti*

#### 5.3.6.1.1.2 Profitability of Wheat R to B model marketing options

Results show most framers realized profit from the wheat enterprise in target area (figure 3). However more profit was made when wheat was sold as seed rather than grain. It was noted that farmers sold their wheat at the farm gate, with only one of their counterpart selling to the millers. Selling to millers attracts additional costs in terms of drying, storage and transportation. Millers do not buy wheat directly from farmers rather, they buy from middlemen at the National Cereals and Produce Board (NCPB) depot where they rent warehouse facilities.

Millers meet the final cost of additional cleaning, drying and grading. This means that the price offered to farmers is less the costs incurred in drying grading and storage. The middleman meets the cost of transportation, drying and initial cleaning. Selling directly to millers will mean farmers could incur the cost of transportation, drying and cleaning (table 8). Due to the delays at the selling point the farmers also incur upkeep costs while waiting to offload. There are also losses associated with petty thefts of the produce during drying and cleaning at the depot.

The selling price were as follows: Farmgate grain:  KES 4,000; Farm gate seed:  KES 6,000; Millers: KES 5000; costs per care varied with level of inputs application.

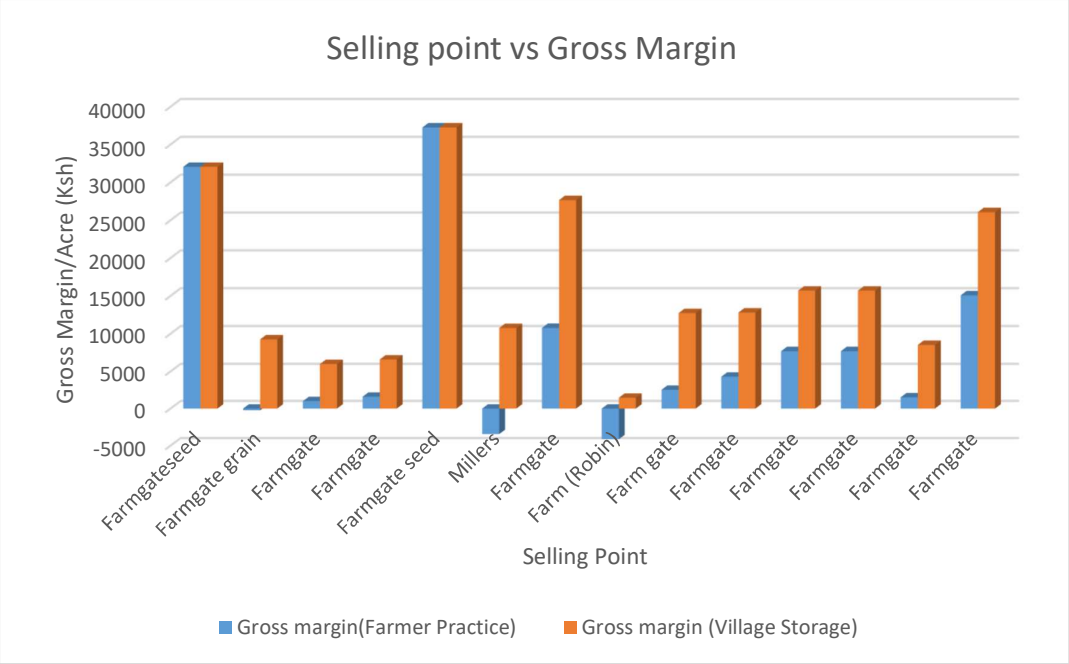



*Figure 3: Gross Margins with farmer practice and village storage*

As noted earlier farmers in Nturumeti prefer selling wheat at the farm gate preferably to the middlemen/brokers at the time of harvest which greatly affect their Gross Margins (GM's). Farmers in Nturumeti attributed this scenario to lack of appropriate storage facilities at the village level which they can use to hold grain till the market prices become favourable. In this scenario farmers would receive higher gross margins compared to farm gate and miller sales.

Farmers who sold to the millers at the NCPB depot made loses (negative gross margins) (figure 3). Variety robin although previously popular with farmers made losses due to its poor yield and vulnerability to diseases stresses. However the scenario can be improved in both cases if the produce is stored till when the market prices improve. On the other hand farmers could be advised to plant more of other varieties than Robin.

*Table 9: Costs associated with direct selling to millers at the NCPB*

| **Item** | **Costs (Kshs)** |
|---|---|
| Transport | 5160 |
| Driver and hand help | 2400 |
| Commissions | 4000 |
| Upkeep for farmer | 4000 |
| Drying | 3870 |
| TOTAL COSTS | **19430** |

*NOTE: The farmer planted 4 acres, Harvested 43 bags sold at ksh.3000. Drying at Kshs. 30/bag/day for 4 days. Had to wait for 4 days at the depot before offloading. Daily upkeep expenses for farmer Kshs 1000 per day, Daily upkeep expenses for driver and hand help Kshs 600 per day, commissions 4000, transportation Kshs 120/bag. Savings per acre 5x3000= 15,000*

Plate 32. Farmer storage facility at Nturumeti

*Results of Sheep R to B model validation*

Validation data for sheep component commenced in December 2015 with the introduction of the lambs in the feedlot.

#### 5.3.6.2.1 Sheep performance during fattening

The health of the sheep was monitored in addition to monitoring the other production parameters. Among the health parameters recorded during this period were worm egg counts, body condition scores and live weights. An initial evaluation of the packed cell volumes was done to ascertain the possible level of anaemia, possibly associated with haemonchosis.

Plate 34. Weighing (L), faecal sampling (M) and deworming (R) the sheep at the feedlot

## Weight gain during period of fattening

The lambs progressively gained weight rapidly up to day 42, stagnated then picked on 99 day (Figure 4). Mean weight gain was 50g/day, which was below the expected rate of 200g/day. This was attributed to a ration that had not been proven which perhaps, did not meet the nutritional requirement of growing lambs. Other factors which may have affected the lambs and which need further research are breed, farmer management of the feedlot and diseases outbreaks including helminth challenge.

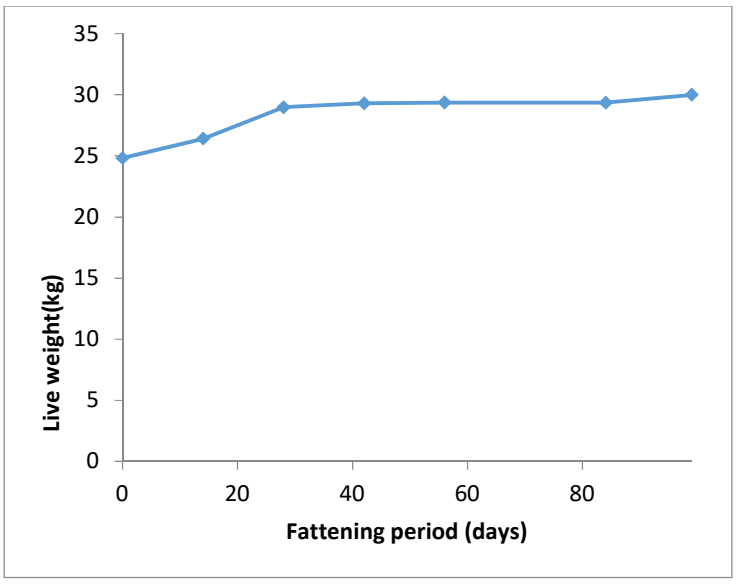



*Figure 4: Growth curve of feedlot sheep at Nturumeti*

However, lambs castrated at least one month prior to entering the feedlot performed better than the lambs castrated on the day of entering the feedlot (Figure 5) perhaps because of the stressed induced by the closed burdizzo castration and hence prior castration is better

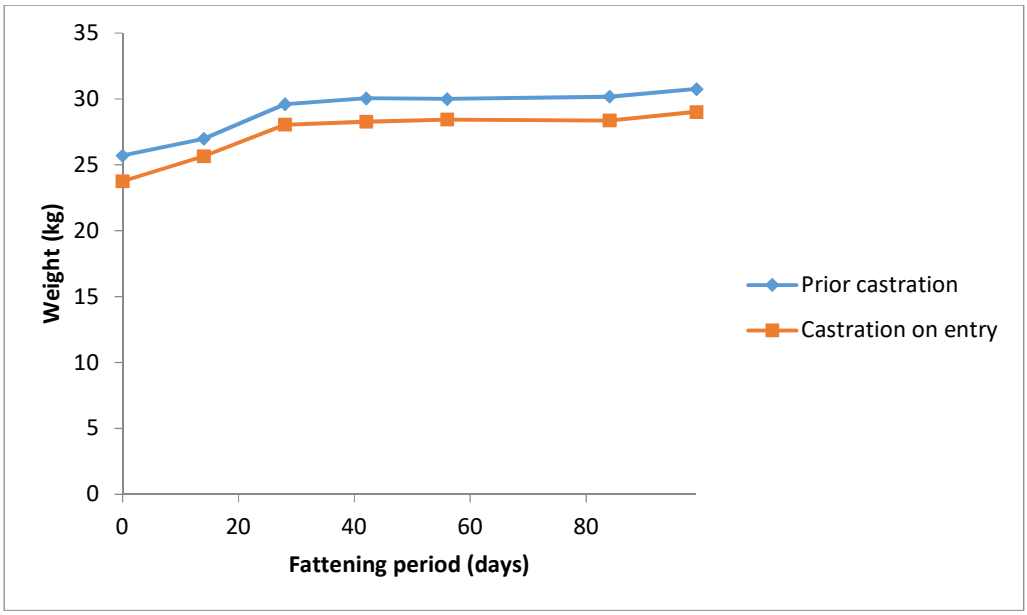



*Figure 5: Effect of time of castration on weight gain of weaner sheep*

Therefore, it is recommended that for on-farm lamb finishing for market, it is good to start with lambs aged 4 months and castrated one month before commencement of the fattening phase. The lambs should be vaccinated against known endemic diseases for example, Nturumeti, sheep pox, blue tongue and enterotoxaemia. Feeding should include both forages and concentrates. Preferably feeds high in energy such as grains are good in supplementing the energy sources of forages molasses and protein concentrates. Mineral licks should consist of balanced commercial products. The equipment for processing forages should be motorized since manually operated are laborious to use. Farmers maximize returns by fattening and marketing lambs when sold on live weight basis.

#### 5.3.6.2.1.2 Helminth infections in the feedlot sheep

The animals were treated with a broad-spectrum anthelmintic (Valbazen$^{R}$ 10%) and a pour-on acaricide (Spoton$^{R}$) applied for the control of ectoparasites. The sheep were faecal sampled at the day of introduction to the feedlot (Day 0), once in the middle of the fattening (Day 84) and at the end of the trial (Day 99). The results of the faecal egg counts over the three sampling periods are summarized on Table 9. The level of infection with gastrointestinal nematodes remained fairly constant throughout the fattening period based on the faecal egg counts. This was in spite of the anthelmintic treatments on Day 0 and Day 84. Upon comparisons of the three breeds in the flock, the Red Maasai had a higher mean worm egg counts followed by the Red Maasai x Merino crosses and Red Maasai respectively (figure 6). This was consistent with known breed susceptibilities to gastrointestinal nematodes (Mugambi, *et al.*, 1997). The possible explanation for the observed moderate infections even after interventions could be the confined grazing which could have predisposed the lambs to high larval challenge. This confinement is not common in the traditional grazing system in the study area where animals are allowed to graze in a wide and dispersed area, thereby exposing them to low helminth challenge.

Pooled faecal samples were cultured and a differential larval (L3) counts carried out on Day 0 samples. This was to determine the common nematode genera in grazing sheep in the trial area. The results showed that *Haemonchus* was the most predominant nematode genera (64%) followed by *Trichostrongylus* (24%), *Strongyloides* (8%) and *Oesophagostomum* (4%). The PCV were within the normal range (14% to 45%). These genera, especially *Haemonchus* or stomach worm which is blood sucker, are among the common and most pathogenic nematodes in grazing ruminants.

*Table 10: Comparison of helminth infection amongst the sheep at the day of introduction to the feedlot and at the day of auction*

| Day of sampling | Number sampled | Mean worm egg counts (epg) |
|---|---|---|
| 0 | 91 | 1140 |
| 84 | 65 | 800 |
| 99 | 95 | 1024 |

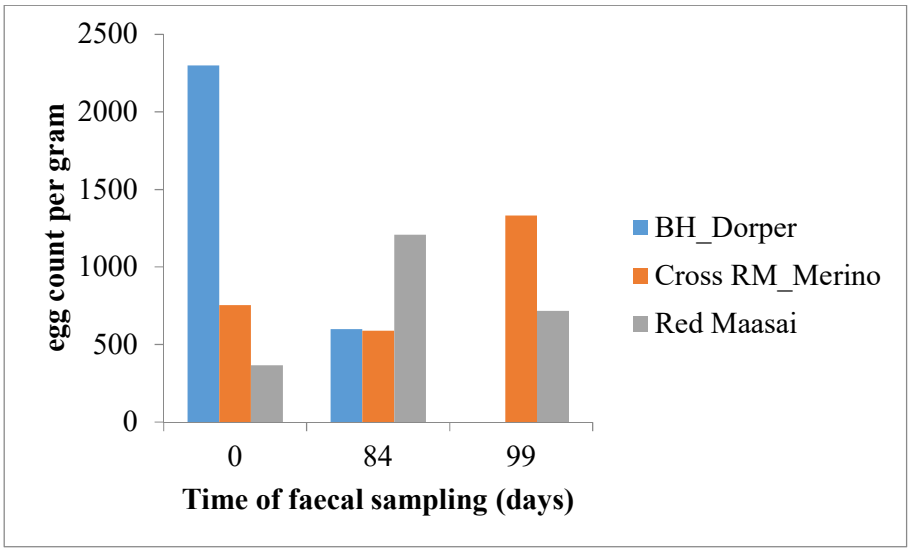



*Figure 6: A comparison of mean faecal egg counts (eggs per gram) for the different sheep breeds at Day) Day 84 and Day 99*

#### 5.3.6.2.1.3 Other diseases encountered

During the fattening scheme, two disease outbreaks were observed in the flock. These were sheep pox and blue tongue. The outbreaks were associated with the introduction of sheep from different farms, some of which could have been incubating the diseases. The two diseases were later contained through vaccination, sheep pox by the project team while blue tongue vaccine was administered with the help of the county veterinary office. The blue tongue outbreak also affected farmers' animals in and around the trial site. Sheep pox is a highly contagious viral disease of sheep characterized by nodules in the mouth, skin, and nose. The nodules can also appear in the tongues and udder. The disease is spread by insects or through contaminated equipment. It is controlled through strict biosecurity and vaccination.

Blue tongue is a viral, non-contagious viral disease that affects many domestic animals although sheep particularly affected. It is characterized by eye and nasal discharges, drooling, fever and swellings in the mouth, head and neck, lameness and respiratory problems. It is controlled through

vaccination. Both sheep pox and blue tongue are important diseases of trade because they are notifiable disease whose outbreaks are followed by quarantine and restriction of animal movements.

A total of six deaths, equivalent to a mortality of 4.5%, occurred during the fattening scheme. This is consistent with observed in sheep farming, particularly in extensive systems. Although no *post mortem* examinations were carried out, these deaths were associated with complications from the disease outbreaks experienced. However, observations made by farmers on three of the dead sheep indicated impaction in the large intestines. They associated this observation to feeding of the sheep with molasses. This could not be independently verified.

#### 5.3.6.2.1.4 Body condition monitoring during fattening period

The health and nutritional status of the lambs in the feedlot was monitored at the point of entry into the fattening scheme and at the end of trial using body condition scoring. The scoring criteria was based on the method for sheep described by Boundy (1982). The details of the criteria are summarized in Table 10.

*Table 11: Body condition scoring in sheep*

| Body condition score | Type | Description |
|---|---|---|
| 1 | Very thin | Spinous process very prominent and sharp; transverse process also easily felt and sharp; fingers can be pushed easily under ends; loin muscle shallow, concave; no fat over muscle, under skin. |
| 2 | Thin | Spinous process prominent but less sharp; transverse process smoother on ends; fingers can be pushed with little pressure under ends; loin muscle more depth and fullness; no discernible fat covering |
| 3 | Average | Spinous process easily felt with finger pressure but smooth not sharp; transverse process smooth and fat covered; firm pressure needed to push fingers under edge; loin muscle full |
| 4 | Fat | Spinous process can be felt with considerable finger pressure; transverse process cannot be felt, ends covered with fat; loin muscle full with cover of fat. |
| 5 | Very fat | Spinous process cannot be felt; back broad with hollow; transverse process cannot be felt; loin very wide and thick over loin edge; evidence of fat around dock extending forward on rump. |

Figure 7 shows a comparison of the body condition scores before and after finishing. The body condition of the weaner lambs improved during the period of finishing. The body condition scores for a majority of the sheep at the beginning of the fattening was between 1 (very thin) and 2 (thin), comprising 69.7% of the flock. This compared to 28.4% in condition 3 (average) and 1.8% in condition 4 (fat). There was none in the 5 score. The corresponding figures for the last day of the finishing (Day 99) were 35.2% for conditions 1 and 2, 47.6% for condition 3, 16.2% for condition 4 and 1.0% for condition5. A chi-square analysis of the body condition data showed that time was

significantly related to the sheep body condition score ($p<0.001$). This indicated that the finishing process improved the overall performance of the flock over time and therefore increased their marketability. This was corroborated by analyses comparing the live weights and the body condition score. The results shown on table 11 indicated a close relationship between the body condition scores and live weight.

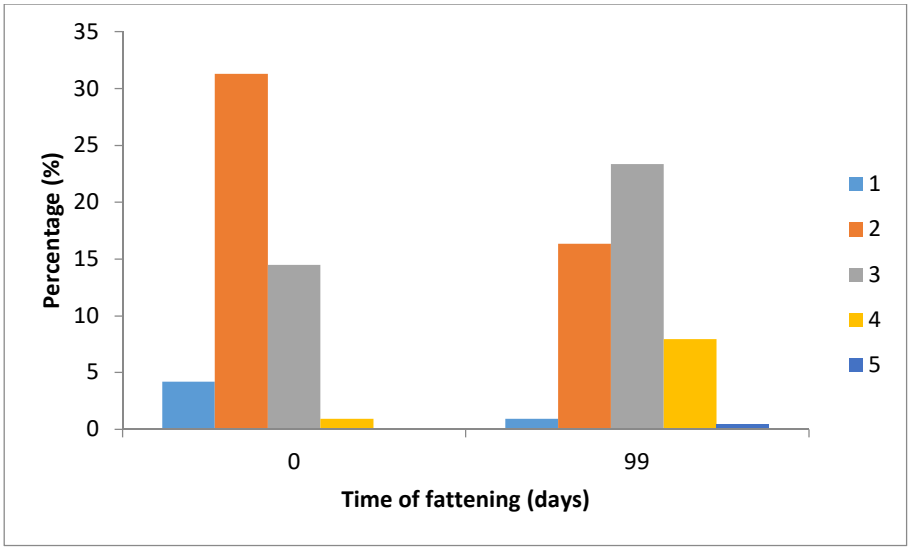



*Figure 7: A comparison of body condition scores of weaner's sheep at the beginning and at the end of the fattening scheme*

The body condition scores were also compared across breeds (table 12) and this shown similarities in the distribution of the body condition scores across the breeds represented in the scheme.

*Table 12: A comparison of the body condition scores and the mean live weights for the sheep at the feedlot*

| Body condition | Mean live weight (kg) | Std. Error |
|---|---|---|
| 1 | 21.2 | 1.39 |
| 2 | 24.4 | 0.46 |
| 3 | 29.5 | 0.52 |
| 4 | 37.0 | 1.06 |
| 5 | 44.0 | 4.61 |

*Table 13: The comparison of body condition scores across breeds*

| **Breed** | **Body condition scores** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| Dorper | 0 | 0 | 1 | 1 | 0 | 2 |
| RM_Merino crosses | 9 | 78 | 52 | 11 | 1 | 151 |
| Red Maasai | 2 | 24 | 28 | 7 | 0 | 61 |
| Total | 11 | 102 | 81 | 19 | 1 | 214 |

Recommendations and way forward

The following were given as lessons learnt and recommendations for sheep fattening/health:

- It is important to vaccinate sheep prior to introduction into the feedlot. In liaison with the county veterinary authorities, the common diseases in the locality can be identified and targeted vaccinations carried out.
- The animals getting into the feedlot should be dewormed 48 hours before so that the grazing paddock for finishing is not subjected to heavy larval contamination, hence heavy helminth infection challenge.
- The ages and live weights for the sheep in the feedlot were not uniform and this could have contributed to the observed variance in the parameters monitored. In future the animals should be similar to enable them respond better to the interventions like diet, deworming, etc.
- The implementation of the weaner lambs finishing experiences some challenges and in future some of the interventions could be handled differently. These include the feeding of the sheep including preparation of the ration, increasing farmer's participation in the scheme and data recording by the farmers and the stockman, especially on events as they happen.
- There are useful lessons learnt during the implementation of the finishing scheme and these will come in handy in future projects.
- Targeted finishing of sheep lambs can be embraced by farmers as a commercial activity that promise to improve their livelihoods.

#### 5.3.6.2.2 The sheep auction sale

Out of the initial 132 animals, 123 lambs were finished and offered for sale by public on 11/4/2016 at the trial site in Nturumeti. Auction attended by farmers, traders, extension officers, scientists, political leaders and other stakeholders. Lambs were put on 10 lots- each 12 animals. Reserve price

was based on live weight at KES 150/kg. The exciting moment of the auction was when a flock of 60 sheep (> 30kgs live weight) were bought at KES 130/kg, paid for on cash on site (KES 297,100).

Initially, the traders present were unable to buy the sheep at the reserve price of KES 150 per kg body weight but one of them offered to buy those weighing 30kg and above for KES 130 per kg. The participating farmers were given time to hold a consultative meeting following which they agreed to take the price offered. A total of 60 sheep (totalling 2099.5kgs) were bought and paid for in cash (KES 297,100) by one trader, leaving another 63 that were below this weight. Subsequently, another trader bought 17 lambs weighing 25-29 kg also on 130/kg (averagely Kshs 3800 apiece). Most of the farmers observed that the new method of sale, live weight basis, was better than visual assessment system. According to the farmers, the finished lambs returned profits of upwards of KES 2300 per lamb and took 3 months to finish as opposed to the farmer practice of fattening for period of more than 3 years.

Plate 35. The chief guest (L) and the Director, ARIRI addressing the meeting

The following day, 12/4/2016, another trader bought 10 lambs weighing 23-24 kgs at Kshs 3600 apiece. The remaining 26 lambs were bought by their individual farmers for resale in other markets at Kshs 3200 per head.

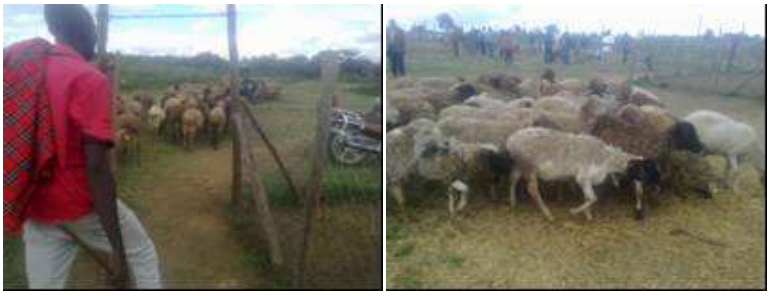


Plate 36. The first lot of 60 lambs sold leaving the feedlot facility

The farmers shared the proceeds as agreed on earlier, after deduction of the agreed 10% proportion for the AFAPO group.

Plate 37. AFAPO officials counting money, proceeds of the first batch of 60 sold out lambs

- The turnover from the finished lambs auction was KES 611,000
- Profit KES 310,000
- Benefit (10%) to AFAPO, KES 61,000
- Proceeds of benefit being used to improve livelihoods - loaning to CBO members and other community members at 10% interest (village table banking) model.

#### 5.3.6.2.3 Evaluating economic profitability and sustainability of the sheep R to B model

Table 13 shows the production norm for sheep fattening regime used in calculation of profitability of the R to b model

*Table 14: Production norm for sheep fattening regime*

| | |
|---|---|
| Construction period (months) | 1 |
| Unit size (no. of lambs per batch) | 132 |
| Frequency of introduction of batch ( months interval) | 6 |
| Age of lambs at the time of purchase (months) | 3-4 |
| Weight at the time of introducing to the feedlot (kg) | 22 |
| Fattening period (days) | 90 |
| Age at the time of sale (months) | 7 |
| Mortality rate | 4.5 |
| Average weight at the time of sale (kg) | 29.8 |

Economic profitability of sheep fattening scheme was evaluated through estimating the expected cost benefit parameters (net present value (NPV), gross margin (GM), benefit cost ratio (BCR) and internal rate of return (IRR)) under different scenario. The estimation were based on an inflation rate of price per annum of 10%, a Depreciation on capital asset of 5%, a discounting rate of 11.50% which is the Current Central Bank of Kenya Interest Rate and Mortality rate per season4.5%. The first scenario is a case whereby the farmer has to buy **132 lamb rams sheep at the age of 3-4 months for fattening and thereafter sell through auction**. In this case the farmer will experience a negative net benefit (NB) of KES 182,043.42 in the first season which are largely contributed by the capital expenditure Appendix 2). The internal rate of return (IRR) of 124.9% indicate that the project will be self-sustainable in future. This IRR implies that for every one Kenya shillings invested, a return of Kenya shilling 124.90 will be realized which is far much above the Kenya commercial banks interest rate that range from 17-26%. The positive net present value (NPV) of KES 1,406,429.48 that is far beyond zero implies that it is profitable investing in sheep fattening scheme. The benefit cost ratio (BCR) less than one indicate that the project will not be able to pay in the first season but the BCR

above one in the second season implies that the project will be breaking even and in any other subsequent season.

The second scenario (the present fattening pilot) is a case whereby the farmers come together and contribute 132 lamb rams sheep for fattening under feedlot system. In this scenario, the computed cost benefit parameters gave a positive NPV and GM and a CBR above on (appendix 3). This means that the costs invested in the sheep lamb rams fattening scheme are recovered and high benefit realized. The discounted NPV was far above zero implying that it worthy investing in sheep lamb rams fattening for enhanced future benefit with a very high IRR of above 500%.

#### 5.3.6.2.4 Factor that influence market participation in the area

1. Distance to the market
2. Prices offered in different market
3. Means of transport to and from the market
4. Gender – men participate more than women
5. Age of the farmer – more youth than old
6. Number of customers
7. Business skills

#### 5.3.6.2.5 Conditions necessary for the sustainability of research to business (r2b) model

1. Land - Land size 15-20Acres – the project cannot be effective in a small land, land should be fenced and accessible. Large land size will enable smooth and effective management of the project
2. Capital (credit facilities)- The project requires affordable and accessible loans
3. Technical services - Accessible to agro-vet services; Animal health Experts and good vet services should be available
4. Feed reserves - The model can attain good result if there is enough feed reserve
5. Water - Clean and reliable.

#### 5.3.6.2.6 Business condition necessary for sustainability of the research to business (r2b) model

1. Enabling government policy -government should enact policies that improve markets for the area
2. Road network - Good roads will make the project site accessible
3. Communication network - Mobile network -should be available for the smooth running of the day to day activities

#### 5.3.6.2.7 Lessons learnt for ensuring profitability of sheep R2B model

1. For sustainable and effectiveness in implementing R2B model on sheep a strong leadership and cooperation among farmers within the group is a necessary.

2. Feed processing should be mechanized
3. The role of each member in the group should be clear and well stipulated
4. A document containing clear guideline on how proceeds will be shared should be in place

#### 5.3.6.2.8 Challenges

The implementation of the weaner lambs finishing experienced some challenges and in future some of the interventions could be handled differently. These include the feeding of the sheep including preparation of the ration, increasing farmer's participation in the scheme and data recording by the farmers and the stockman, especially on events as they happen.

The fattening period coincided with a heavy rainfall season that caused the flaring up of sheep viral conditions (sheep pox, blue tongue). Difficulties with Lack of close technical supervision resulted in improper feeding of some feed ingredients such as molasses that farmers observed caused impaction at the colon leading to death. The manual chaff cutter was laborious for the pastoral community to use. This hampered the processing of the feed forages for the fattening sheep. The lambs were not screened for known antibodies prior to the fattening period which may have resulted into the recruitment of lambs incubating infectious diseases.

The government procurement procedures delayed the access of certain inputs that caused delay in operationalization of planned field activities. Livestock production in the pastoral community is done communally and even though this practice is changing to sedentary livestock rearing, in many occasions freely roaming livestock were braking the external perimeter fence and enter the feedlot facility, a condition resulted into unnecessary interference of feedlot operations.

### Output 5.4 Project coordination enhanced

#### *Activity 5.4.1 Hold annual review and planning workshops*

- A 2 day consultative planning workshop was held from 23rd to 24th June 2014 at KARI Muguga South center – involving 16 participants among them farmers, extensionists, scientists and one animal specialist from ICARDA/ILRI (Dr Barbara) - Addis Ababa office. Draft concept and workplan was developed and submitted to the Regional Coordinator who gave feedback that was incorporated in the finalization of the workplan. Participants sensitized on objectives and goals of the project
- A second annual planning and review workshop was held on 18-20th May 2015 with the following outputs:
    - progress of the project was presented by component PIs and way forward agreed upon
    - Elements and framework for the upscaling phase was elaborated forming the basis for deliberations of the proposed 2015/16 activities
    - Key elements of the 2015/16 workplans was discussed and agreed upon

#### *Activity 5.4.2: Hold coordination meetings*

- Coordination meeting was held on 15-16 January 2015 to
    - review progress and way forward on survey data analysis and reporting
    - plan for inception workshop

- A coordination meeting was held with the sheep component team on 24-25th March 2015 with the objective of refining the sheep finishing intervention with regard to
    - the carrying capacity for the fattening plot,
    - ration formulation,
    - data to be collected at various stages and the mode of collection which should be guided by the budget
    - Scheduling of activities i.e. before, leading up to, and during fattening period
    - detailing the market innovation
    - deliberation on any other pertinent issues key to the project implementation
- A coordination meeting was held October 2015 at Naivasha with the wheat team to finalise data analysis for the wheat R to B model
- A coordination meeting was held in January 2016 to discuss progress on sheep component
- A coordination meeting was held in April 2016 to finalise data analysis of project data and initialise final technical report writing.

*Activity 5.4.3 Monitoring of project activities*

Several monitoring missions were undertaken to project cation sites to assess progress of the implementation with a view to finding solutions to emerging challenges and take advantage of evolving opportunities as follows:

- 6th to 10th July, 2015; monitored training activity; witnessed handover of breeding rams; monitored progress of the wheat fields
- 24th to 25th March 2015; firmed up on the elements of the sheep intervention and discussed development of feed rations for the sheep fattening operation with project scientists
- 17th -21st May 2015; reviewed progress on planting of the wheat fields

*Activity 5.4.4 Engage with partners to establish synergies and complementarities*

**i. Visit to Kenya IFAD office- 24th March 2015**

- Dr. Keya and Mr. Kibet visited IFAD regional office at UN complex in Gigiri to introduce the on-going IFAD-ICARDA project funded by IFAD. The two IFAD officers (Ms. Faten Bokri and Mr. Peter Yuexiong) were met and a briefed on the status of project by the National Project Coordinator. The aim of the visit was to see where the project could synergies with other IFAD funded project in the country.

- On the other hand the IFAD officers stated that their office supports cereal farmers through Cereal Enhancement Support Project implemented in collaboration with the Ministry of Agriculture, Livestock and Fisheries, a project implemented in three counties including of Nakuru, and Kitui. They further stated that IFAD is not funding livestock projects which could collaborate with our project. The IFAD country project does not operate in Nark where ICARDA Phase 2 is being implemented and therefore there was little room for synergies.

**ii. Visit with IFAD Investments in the State Department of Agriculture and State Department of Water and Irrigation, Kenya**

On 19th August 2015 Dr Keya visited the State Department of Agriculture and State Department of Water and Irrigation, Kenya with the main purpose being to get acquainted with IFAD investments in Kenya and explore possibilities for synergies and collaboration with Kenya Agricultural and Livestock Research Organization (.KALRO) project research team. Below are a summary of offices visited, the people met, projects being implemented and some action points of this visit:

- **Mr Peter Yuexiong SITU** is the EU Regional Programme manager, Regional office in Nairobi, ESA, IFAD UN Complex, Block U, UN Avenue, Gigiri, P.O Box 67578, 00200 Nairobi, Kenya; tel: +254 (0) 20762 1019; mobile: +254 (0) 719 867911; email: p.situ@ifad.org
- **Mr Patrick Onchiku** is the current Desk Officer for IFAD in the State Department of Agriculture (SDA): Principal Secretary SDA, email: ponchiku@gmail.com; mobile: 0725696693
- Only the Small Holder Horticulture Project (SHHP) is domiciled here
- Kenya Cereals Enhancement Project (KCEP) was until recently domiciled here but has relocated elsewhere. Mandate area covers a) highland zone of Kitale, Trans-Nzoia, Bungoma, Nandi, Nakuru, Embu, Tharaka Nithi Kitui b) marginal zones of Taita Taveta, Kwale and Kilifi.
- Crops targeted in highland zone are maize and beans
- Crops targeted in marginal zone are sorghum, finger millet and associated pulses (beans, green grams and pigeon peas
- Approach for KCEPM is subsidized farm inputs (fertilizer through e-voucher system managed by equity bank. KALRO role will be provision of seed (through KALRO seed unit) especially for the marginal crops. The same 20 farmers from Nturumeti village who cultivated improved wheat varieties are also participating in sheep fattening.
- Ms Maryanne Njogu is the programme Manager of KCEP; tel. 072281344 ; Nyakundi Mogere (Finance and Administration)
- **Mr T. O Milewa** is the Desk Officer for IFAD investments in the State Department of Water and Irrigation (SDWI)- Principal Secretary, SDWI ; Maji House : Tel +254-20-2716103 ext. 42242; Room 220 second floor; email: thomilew@yahoo.com; Ngong Road, Box 49720-00100 Nairobi Kenya
- Upper Tana Catchment Natural Resources management project (UTANRMP 2012-2020) is domiciled in the State Department of Water and Irrigation. SDWA is the lead agency in the implementation of UTANRMP)
- Project goal is contribute to the reduction of rural poverty in the upper Tana river catchment through increased sustainable food production and incomes for poor rural households, as well as sustainable management of natural resources
- Target areas for UTANRMP are Embu, Meru, Kirinyaga, Mweiga
- UTANRMP Secretariat and operational office is located in Embu. The Project coordinator is **Ms Muthoni F. Livingstone** (utanrmp@gmail.com; mobile: 0722596987)
- The programme for Rural Outreach of Financial Innovations and Technologies (PROFIT 2010-2016) is domiciled at the National Treasury as the leady agency..

- The goal of PROFIT is to increase the incomes of the target group by improving production and productivity of rural small farm and off-farm sectors. It is implemented in ASALS and areas with agricultural potential and a high incidence of poverty
- Desk officer of PROFIT is **Stephen Onchoke**: mobile 0722297233 or **Ronald Ajengo** – Managing accountant: 0727802179; Principal Secretary, National Treasury, Treasury
- Head of IFAD Project Coordination (Kenya) **Ms Philomena Chege**; mobile 0722804994, Hill Plaza Building

1. *Immediate action point:*
    - Contact PROFIT manager and explore synergies and collaboration
    - Contact UTANRMP project Coordinator and arrange a visit to explore synergies and collaboration
2. Overall impression

There is scope for collaboration with the UTARMP in the following areas

- Wheat R to business Model in Mweiga and West of the Mt Kenya where wheat farming is component of the production systems
- Sheep R to B models in areas of the Mt Kenya region where small ruminant a component of the livestock production systems
- The wheat and sheep R to B models could also benefit from the natural resources conservation of the UTARMP project

### *Activity 5.4.5 Monitoring of project progress*

In the course of the project period several monitoring missions were undertaken to gauge progress and address emerging challenges.

### *Activity 5.4.6 Attend conferences (local and regional)*

The sheep component PI Mr Katiku, was facilitated through the project to attend the Annual Animal Production Society of Kenya Symposium held on 20-21 April 2015 where he presented a paper on results of the baseline survey entitled ***"The status of smallholder sheep production in selected Arid and Semi-arid Areas of Narok County, Kenya"***

Co-PI of the sheep component, Dr Nginyi, was facilitated to attend the Kenya Veterinary Association (KVA) scientific symposium in April 21-23, 2015 at Busia, Kenya where he presented a paper on "***Helminthoses and other disease challenges of sheep in the integrated livestock and wheat farming systems of dry areas of Narok County, Kenya"***

### Publications and Reports

**Keya G.A, Katiku PN, Mahagayu, Manyeki JK, Nginyi JM, Amboga SS, Njau P, Mahagayu CM, Kibet PF (2015)**. ***Baseline survey report of the wheat-sheep production system in lower Narok, Kenya.*** **KALRO-ICARDA Project Publication**

**Katiku PN, Manyeki JK, Nginyi JM, Kimitei RK, Amboga SS, Ogillo BP, Njau p, Mahagayu CM, Mnene WN, Keya GA, Kibet PF. 2015**. ***The status of smallholder sheep production in***

***selected Arid and Semi-arid Areas of Narok County, Kenya*.** Paper presentated at the Animal Production Society of Kenya (APSK) scientific symposium in April 21-23, 2015 at Sarova Whitesands Beach Resort & Spa, Mombasa.

**Nginyi J.M., Katiku P.N., Manyeki J.K., Keya G.A., Kibet P.F. 2015.** ***Helminthoses and other disease challenges of sheep in the integrated livestock and wheat farming systems of dry areas of Narok County, Kenya***. Paper presented at the Kenya Veterinary Association (KVA) scientific symposium in April 21-23, 2015 at Busia, Kenya

**Keya G.A, Katiku, P and Kibet, PFK (2014)** ***Report of the KALRO-ICARDA workshop on harmonizing checklists at KALRO Naivasha centre and pretesting of the baseline data collection tool in Narok County***. KALRO, Nairobi, September 2014

**Keya G.A and Kibet, PFK (2014)** ***Field report on visiting of Narok County on finalizing workplans/budgets and selection of potential project implementation sites.*** KALRO, Nairobi August 2014.

**G. Keya (2015)** ***Report of the Review and Planning Workshop held on 17-20 May 2015 at KARLO Muguga Retreat and Field Visit to Implementation Sites***. KALRO, Nairobi, May 2015

**Kibet, PFK and Keya G.A (2015)** ***Report on attending R2B Sheep component of IFAD-ICARDA Project Meeting, 24-25$^{th}$ March 2015*****. KALRO, Nairobi**

**G.A Keya (2015).** ***Back to office report on baseline Survey Data Analysis and Reporting Workshop, held at Narok 8-11th December 2014.*** **KALRO, Nairobi. December 2015**

### Major constraints

A major constraint that the project continues to face is lack of funds to carry out critical activities.

## Appendix 1: Case studies of production costs associated with wheat farm operations for Nturumeti farmers participating in the Wheat R to B model.

**Case study 1**

Farmer Kamau planted 4 acres, Harvested 43 bags sold at ksh.3000. Drying at Kshs. 30/bag/day for 4 days. Had to wait for 4 days at the depot before offloading. Daily upkeep expenses for farmer Kshs. 1000 per day, Daily upkeep expenses for driver and hand help Kshs 600 per day, commissions 4000, transportation Kshs 120/bag. Savings per acre 5x3000= 15,000

Table 14. Farm operation activities and costs for farmer 1

| Main Operation | Input item | Input type | Quantity | Rate (Kshs) | Total cost (Kshs) |
|---|---|---|---|---|---|
| Land preparation | Ploughing | tractor | 2 | 2000 | 4,000 |
| | Harrowing | tractor | 1 | 1400 | 1,400 |
| | | | | **subtotal** | **5,400** |
| Planting | seed | Njoro 2 | 2 | 3750 | 7,500 |
| | planter | | 2 | 1100 | 2,200 |
| | fertilizer 1 | DAP | 2 | 2500 | 5,000 |
| | Labour | | 3 | 200 | 600 |
| | **subtotal** | | | | **15,300** |
| Topdressing | | | | | |
| | Foliar feed 1 | booster | 5 | 800 | 4,000 |
| | Labour | Tractor | 2 | 400 | 800 |
| **subtotal** | | | | | **4,800** |
| Weeding | herbicide 1 | Buctril | 1 | 3000 | 3000 |
| | **Labour** | | 2 | 400 | 800 |
| | | | | **subtotal** | **3800** |
| Pest/disease control | | | | | |
| Fungicides | Fungicide 1 | Swing | 1 | 800 | 800 |
| twice | Fungicide 2 | | 2 | 1500 | 3000 |
| | **Labour** | | 2 | 400 | 800 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | **subtotal** | **4600** |
| Harvesting | harvester | combine | 2 | 2000 | 4000 |
| | | | **subtotal** | | **4000** |
| | | | | | |
| **TOTAL** | | | | | 37,900 |

**Case study 2:**

Farmer Simon Naikuni had low yields of 1 bag/acre (0.1 tonnes) which was inconsistent with a production cost of Kshs. 14,875/acre investment. He attributed low yield to wrong planter not well calibrated, poor spacing, too much rain and low rainfall during maturity leading to crop failure. We noted that the farmer spent most of the time on off-farm employment activities and had minimal supervision over wheat farm activities. Infact, the farmer confided that most of the inputs were donated by relatives and fellow farmers. However although the expenditure reported for farm operations is relatively high it was doubtful whether this reflected the actual expenditure.

Table 15. Farm operation activities and costs for farmer 2

| Main Operation | Cost item | Input | Quantity | Rate (Kshs) | Total cost (Kshs) |
|---|---|---|---|---|---|
| Land preparation | chiseling1 | tractor | 1 | 2000 | 2,000 |
| | Disc | tractor | 1 | 2500 | 2,500 |
| | Harrow | tractor | 2 | 1800 | 3,600 |
| | Round up | | 2 | 700 | 1,400 |
| | | | | **subtotal** | **9,500** |
| Planting | seed | eagle 10 | 2 | 3750 | 7,500 |
| | planter | | 2 | 1800 | 3,600 |
| | fertilizer 1 | DAP | 2 | 3000 | 6,000 |
| | **subtotal** | | | | **17,100** |
| Topdressing | | | | | |
| | Foliar feed 1 | Agrigreen | 5 | 1000 | 5,000 |
| | Foliar feed 2 | CAN | 1 | 2000 | 2,000 |
| | Labour | Spray | 2 | 200 | 400 |
| | Labour | CAN | 2 | 500 | 1,000 |
| **subtotal** | | | | | **8,400** |
| Weeding | herbicide 1 | 24 D | 1 | 1200 | 1200 |
| | herbicide 2 | puma super | 1 | 3000 | 3000 |
| | herbicide 3 | Glean | 5 | 400 | 2000 |
| | **Labour** | | 2 | 500 | 1000 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | **subtotal** | **7200** |
| Pest/disease contol | | | | | |
| Fungicides | Fungicide 1 | Silvacur | 1 | 2000 | 2000 |
| | Fungicide 2 | Folicur | 1 | 1800 | 1800 |
| | Fungicide 3 | Bulldoc | 2 | 1700 | 3400 |
| | **Labour** | | 2 | 500 | 1000 |
| | | | | **subtotal** | **8200** |
| Harvesting | havester | combine | 2 | 2000 | 4000 |
| | drying labour | | 1 | 200 | 200 |
| | | | **subtotal** | | **4200** |
| **TOTAL** | | | | | 54,600 |

**Case study 3**

Farmer James Naimodu from Ololulunga planted variety Eagle 10 which he attained an average yield of 4 bags/acre (0.4 tonnes) at a total production cost of Kshs. 27,300/acre investment. He attributed this to the unsuitability of the two sites planted with wheat stating that one of the sites had been continuously planted with wheat, attack of pests and diseases, poor land preparation by use of a disc plough instead of chisel plough on one of the plots and late planting .However in the course of the interview he had little knowledge on the pesticides and fungicides, particularly on the application rates which appeared to be higher leading to high production costs. The lapse in knowledge about rate of input could also mean that actual application was much less than what the farmer reported. The farmer sold his harvest at a very low price of Ksh.2500 per bag. He explained that this was because of the low volume involves thus making him a price taker from the middlemen

Table 16. Farm operation activities and costs for farmer 3

| Main Operation | Cost item | Input | Quantity | Rate (Kshs) | Total cost (Kshs) |
|---|---|---|---|---|---|
| Land preparation | chiseling1 | tractor | 1 | 2000 | 2,000 |
| | Disc | tractor | 1 | 2500 | 2,500 |
| | Harrow | tractor | 2 | 1800 | 3,600 |
| | Round up | | 2 | 700 | 1,400 |
| | | | | **subtotal** | **9,500** |
| | | | | | |
| Planting | seed | eagle 10 | 2 | 3750 | 7,500 |
| | planter | | 2 | 1800 | 3,600 |

| | | | | | |
|---|---|---|---|---|---|
| | fertilizer 1 | DAP | 2 | 3000 | 6,000 |
| | **subtotal** | | | | **17,100** |
| Topdressing | | | | | |
| | Foliar feed 1 | Agrigen | 5 | 1000 | 5,000 |
| | Foliar feed 2 | CAN | 1 | 2000 | 2,000 |
| | Labour | Spray | 2 | 200 | 400 |
| | Labour | CAN | 2 | 500 | 1,000 |
| **subtotal** | | | | | **8,400** |
| Weeding | herbicide 1 | 24 D | 1 | 1200 | 1200 |
| | herbicide 2 | puma super | 1 | 3000 | 3000 |
| | herbicide 3 | Glean | 5 | 400 | 2000 |
| | **Labour** | | 2 | 500 | 1000 |
| | | | | **subtotal** | **7200** |
| Pest/disease control | | | | | |
| Fungicides | Fungicide 1 | Silvacur | 1 | 2000 | 2000 |
| twice | Fungicide 2 | Folicur | 1 | 1800 | 1800 |
| | Fungicide 3 | Buldoc | 2 | 1700 | 3400 |
| | **Labour** | | 2 | 500 | 1000 |
| | | | | **subtotal** | **8200** |
| Harvesting | harvester | combine | 2 | 2000 | 4000 |
| | drying labour | | 1 | 200 | 200 |
| | | | **subtotal** | | **4200** |
| **TOTAL** | | | | | 54,600 |

**Case study 4: Moiben Middleman**

Mr Cheruiyot is a middleman from Moiben, about 300km from Nturumeti. He is a truck owner. He buys wheat at Kshs 2700 to 2800 at farm gate for properly dried produce. Otherwise, he determines moisture at the point of buying and levies a drying penalty of one kilogram (kg) per unit moisture above 13% which means if the wheat is not well dried the farmer is paid less. He aggregates the produce from several farmers and sun dries it at a cost (in terms of payments to the casuals). Drying is done in open fields which are rented at a fee. He sells his produce to the millers at Kshs. 3000/bag whereby he makes a profit of Kshs 50 /bag after deducting all his costs. Transportation is done by his own trucks. It was noted that the middleman could be making his profit through exaggeration of the moisture content (MC). Assuming he deducts 1 Kg per bag for 10 bags = 10kgs, 10x30 =Ksh300.

**Moisture content (MC)**

Moisture content greatly affects quality of wheat, for sale to the market more emphasis is laid on the moisture content. It is therefore to note that for every unit above 13 % MC he deducts a kilogram. Assuming the moisture content is 18% this leaves him with 5 units above the required 13%. For 5 units @ Kshs 30/moisture unit, it will be equivalent to Kshs 150, assuming it is 10 bags @150 it will amount to Kshs 1500. Per acre he gets 5 bags which the farmer foregoes during harvesting. Wheat is not weighed at the farm. Selling price is about Kshs 3000 which translates to about Kshs 15,000. If all the costs are aggregated it amounts to Kshs16, 800. If the farmers were to sell to the miller the marketing costs will always account for 23% of the total cost of the wheat produced. If the storage facility is established the farmers will be able to avoid profit that goes to the middleman and benefit from better prices.

## Appendix 2: Projected cash flow analysis of sheep R tom B fattening model – Scenario 1

Table 17: First Scenario (lambs bought at prevailing market prices) - Cash Flow Analysis and projections for three years- Ram Fattening

| **Cash Flow Analysis and projections for three years- Ram Fattening** | | | | | | |
|---|---|---|---|---|---|---|
| | **YEAR 1** | | **YEAR 2** | | **YEAR 3** | |
| **Input Costs** | **1st Batch** | **2nd Batch** | **3rd Batch** | **4th Batch** | **5th Batch** | **6th Batch** |
| **Balance B/F** | **0** | **(182,043)** | **35,5745** | **253,193** | **499,548** | **853,032** |
| **Capital expenditure** | | | | | | |
| Rams pen - Materials only | 13,250 | 6630 | 663 | 663 | 6630 | 663 |
| Shepherd shelter - Materials only | 9,520 | 476 | 476.00 | 476 | 476 | 476 |
| Equipment - Chaff Cutter | 20,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Hay barn - Materials only | 60,440 | 3,022 | 3,020 | 3,022 | 3,022 | 3,022 |
| Fencing - Materials only | 186,600 | 9,330 | 9,330 | 9,330 | 9,330 | 9,330 |
| Feeding and watering troughs - Materials only | 25,000 | 1,250 | 1,250 | 1,250 | 1,250 | 1,250 |
| Cost of Labour (Fencing, Pen, Hay barn, Toilet, normal maintenance) | 49,224 | - | - | - | - | - |
| ***Total of capital expenditure*** | **364,034** | **15,741** | **15,741.** | **15,741** | **15,741** | **15,741** |
| | | | | | | |
| **Recurrent expenditure** | | | | | | |
| Cost of Lambs* (Market value of weaner rams) | 395,500 | 395,500 | 395,500 | 435,050 | 435,050 | 435,050 |
| Cost of pasture establishment and hay harvesting (10 acres) | 211,333 | 106,333 | 106,333 | 113,451 | 113,451 | 113,451 |
| General Animal Husbandry Practices | 87,551 | 87,551 | 87,551 | 94,421 | 94,4210 | 94,421 |
| Gum boots for farmers | 2,610 | - | - | - | - | - |
| Metal tool box | 1,400 | - | - | - | - | - |
| Cost of Veterinary care | 24,670 | 24,670 | 24,670 | 27,137 | 27,137 | 27,137 |
| Cost of feed, protein and energy concentrates | 148,760 | 148,760 | 148,760 | 163,636 | 163,636 | 163,636 |
| Auction Cost | 8,850 | 8,850 | 8,850 | 9,735 | 9,735 | 9,735 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Total of recurring expenditure*** | **880,674** | **771,664** | **771,664** | **843,430** | **843,430** | **843,430** |
| | | | | | | |
| **Total costs** | **1,244,708** | **787,405** | **787,405** | **859,171** | **859,171** | **859,171** |
| 1% Miscellaneous | 12,447 | 7,874 | 7,875 | 8,592 | 8,592 | 8,592 |
| **Grand Total** | **1,257,155** | **795,279** | **795,279** | **867,763** | **867,763** | **867,763** |
| | | | | | | |
| **Benefit** | | | | | | |
| Sale of rams | 973,912 | 973,912 | 973,912 | 1,071,303 | 1,178,434 | 1,296,277 |
| Hay | 11,200 | 31,111 | 31,111 | 34,222 | 34,222 | 34,222 |
| Wheat grain (30Bags) | 90,000 | - | - | - | - | - |
| Value of sheds and equipment @ depreciation of 5% per year | - | - | - | - | - | 285,332 |
| ***Total Benefit*** | **1,075,112** | **1,005,023** | **1,005,023** | **,105,525** | **1,212,656** | **1,615,8312** |
| | | | | | | |
| **Net Benefit** | **(182,043)** | **35,579** | **253,193** | **499,548** | **853,032** | **1,609,692** |
| | | | | | | |
| **Cost Benefit Analysis** | | | | | | |
| **Gross Margin (GM)** | **(182,043)** | **209,744.23** | **209,744.23** | **237,762.78** | **344,893.10** | **748,067.95** |
| Present Value of Costs @ 11.50% | 1,127,494 | 713,255 | 713,255 | 778,263 | 778,263 | 778,263 |
| Present Value of Benefit @ 11.50% | 964,226 | 901,366 | 901,366 | 991,503 | 1,087,584 | 1,449,175 |
| NPV @ 11.50% per batch | (163,268) | 188,111 | 188,111 | 213,240 | 309,321 | 670,913 |
| **Cumulative NPV** | | **1,406,430** | | | | |
| **BCR** | **0.9** | **1.3** | **1.3** | **1.3** | **1.4** | **1.9** |
| **IRR** | | **124.9%** | | | | |

## Appendix 3: Projected cash flow analysis of sheep R tom B fattening model – Scenario 2

Table 115: Second Scenario (lambs from farmers own flock) - Cash Flow Analysis and projections for three years- Ram Fattening

| | **YEAR 1** | | **YEAR 2** | | **YEAR 3** | |
|---|---|---|---|---|---|---|
| **Input Costs** | **1st Batch** | **2nd Batch** | **3rd Batch** | **4th Batch** | **5th Batch** | **6th Batch** |
| Balance B/F | 0 | 217,412 | 830,530 | 1,443,648 | 2,125,053 | 2,913,587 |
| **Capital expenditure** | | | | | | |
| Rams pen - Materials only | 13,250 | 663 | 663 | 663 | 663 | 663 |
| Shepherd shelter - Materials only | 9,520 | 476 | 476 | 476 | 476 | 476 |
| Equipment - Chaff Cutter | 20,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Hay barn - Materials only | 60,44 | 3,022 | 3,022 | 3,022 | 3,022 | 3,022 |
| Fencing - Materials only | 186,600 | 9,330 | 9,330 | 9,330 | 9,330 | 9,330 |
| Feeding and watering troughs - Materials only | 25,000 | 1,250 | 1,250 | 1,250 | 1,250 | 1,250 |
| Cost of Labour (Fencing, Pen, Hay barn, Toilet, normal maintenance) | 49,224 | | | | | |
| ***Total of capital expenditure*** | **364,034** | **15,741** | **15,741** | **15,741** | **15,741** | **15,741** |
| | | | | | | |
| **Recurrent expenditure** | | | | | | |
| Cost of Lambs* (Market value of weaner rams) | - | - | - | - | - | - |
| Cost of pasture establishment and hay harvesting (10 acres) | 211,333 | 106,333 | 106,333 | 113,451 | 113,451 | 113,451 |
| General Animal Husbandry Practices | 87,551 | 87,551 | 87,551 | 94,421 | 94,421 | 94,421 |
| Gum boots for farmers | 2,610 | - | - | - | - | - |
| Metal tool box | 1,400 | - | - | - | - | - |
| Cost of Veterinary care | 24,670 | 24,670 | 24,670 | 27,137 | 27,137 | 27,137 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cost of feed, protein and energy concentrates | 148,760 | 148,760 | 148,760 | 163,636 | 163,636 | 163,636 |
| Auction Cost | 8,850 | 8,850 | 8,850 | 9,735 | 9,735 | 9,735 |
| ***Total of recurring expenditure*** | **485,174** | **376,164** | **376,164** | **408,380** | **408,380** | **408,380** |
| | | | | | | |
| **Total costs** | **849,208** | **391,905** | **391,905** | **424,121** | **424,121** | **424,121** |
| **1% Miscellaneous** | **8,491** | **3,920** | **3,911** | **4,241** | **4,241** | **4,241** |
| **Grand Total** | **857,700** | **395,824** | **395,824** | **428,362** | **428,362** | **428,362** |
| | | | | | | |
| **Benefit** | | | | | | |
| Sale of rams | 973,912 | 973,912 | 973,912 | 1,071,303 | 1,178,434 | 1,296,277 |
| Hay | 11,200 | 31,111 | 31,111 | 34,222 | 34,222 | 34,222 |
| Wheat grain (30Bags) | 90,000 | - | - | - | - | - |
| Value of sheds and equipment @ depreciation of 5% per year | | | | | | 285,332 |
| **Total Revenue** | **1,075,112** | **1,005,023** | **1,005,023** | **1,105,525** | **1,212,656** | **1,615,831** |
| | | | | | | |
| **Net Benefit** | **217,412** | **830,530** | **1,443,648** | **2,125,053** | **2,913,587** | **4,105,297** |
| | | | | | | |
| **Cost Benefit Analysis** | | | | | | |
| GM | 217,412 | 609,199 | 609,199 | 677,163 | 784,294 | 1,187,469 |
| Present Value of Costs (PVC) @ 11.50% | 769,238 | 354,999 | 354,999 | 384,181 | 384,181 | 384,181 |
| Present Value of Benefits (PVB) @ 11.50% | 964,226 | 901,366 | 901,366. | 991,501 | 1,087,584 | 1,449,175 |
| NPV @ 11.50% per batch | 194,988 | 546,367 | 546,367 | 607,321 | 703,402 | 1,064,994 |
| Cumulative NPV | | **3,663,440** | | | | |
| Benefit Cost Ratio (BCR) | **1.3** | **2.6** | **2.6** | **2.6** | **2.9** | **3.8** |
| IRR | | **>500%** | | | | |

# SUDAN FINAL TECHNICAL REPORT

**Project:**

**Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry land Areas**

**Consolidated Year 1 and Year 2 Reports (ending March 12th, 2016) – Sudan**

**National Coordinator: Dr. Abdelaziz Abdelfattah Hashim**

**Agricultural Economics and Policy Research Centre**

**Agricultural Research Corporation**

## Introduction:

The project on "Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry land Areas" (Phase II) has two objectives or components:

1. Development of profitable and climate change-proof packages/models of tested and proven technology options,
2. Facilitation of the institution and policy environment for an accelerated scaling up of these technologies;

The Project stressed the following two points:

- The research-to-business model of Phase II should start on a solid basis. There is a need first to package the technologies and experience of Phase I, and to understand the value chain of the technologies to be promoted.

- It is important to link the project with existing IFAD-funded projects operating in the area in order to identify the entry points of collaboration, which will add value to IFAD's investments.

In Sudan, the following points were considered:

- Pipe conveyance water saving technology was selected as the priority intervention from Phase I to be scaled up in Phase II and Lower Atbara River was identified as the geographical area for the scaling up of the pipe conveyance technology.
- IFAD investment project "Butana Integrated Rural Development Project" has a window for micro credits, which are provided to small-scale producers through the Agricultural Bank of Sudan. IFAD investment project will support IFAD grant project in scaling up the pipe conveyance technology in Lower Atbara River to benefit around one thousand small-scale producers through facilitating the provision of micro credits. The scaling up will take place in the second year of Phase II.

- In addition to the provision of micro credits, targeted small-scale producers will be guided with a menu of improved crop varieties and agronomic practices tested in Phase I, which they can grow in their fields irrigated by the pipe conveyance technology. This menu includes improved wheat, faba bean, chickpea and common bean varieties, in addition to forage crops and vegetables. Improved livestock production will also be practiced, where it is appropriate.

- Innovation platforms implementing pipe conveyance technology with a menu of improved crops and agronomic practices will be established in the first year of Phase II. These platforms will bring together relevant stakeholders, including the small-scale producers who will be benefiting from the micro credits in the second year of this phase. The economic performance of these platforms will be assessed in order to inform and guide the decision-making of beneficiaries.

This first year witnessed packaging and further validation of the results of the first phase with research gap filling and at the same time, the elements of the research-to-business model will be developed with ICARDA's support for full implementation in the subsequent season.

According to the work plan, four activities were carried out in the project area. These activities are:

- On-farm Demonstration, Training and Dissemination of Improved Wheat and Winter Grain Legumes (Faba Bean, Chickpea and Common Bean) in Lower Atbara River Area,
- Water saving technology (pipe conveyance irrigation system),
- Improved livestock production
- Socioeconomics studies

**Activity 1: On-Farm Demonstration, Training and Dissemination of Improved Production Technologies of Wheat and Winter Grain Legumes (Faba Bean, Chickpea and Common Bean) in Lower Atbara Area**

**Crop Season 2014-2015 - Final Report**

**Scientist:** ***Omer H. Ibrahim, Hudeiba Research Station***

## INTRODUCTION

The on-farm activities during the crop season 2014/2015 were carried out at four testing sites (villages) namely, Albiara-1, Albiara-2, Gangari and Algilaia in Lower Atbara Area. In each village a demonstration model was executed in a way that the four targeted crops namely, wheat, faba bean, common bean and chickpea were demonstrated to farmers at each site. In addition, farmers' field days were carried out in collaboration with IFAD team at both on-farm (Albiara-1) and research (Hudeiba Research Farm) levels.

Generally, the on-farm activities in Lower Atbara area were carried out with following objectives:

1. To expose and train many farmers in Lower Atbara Area on improved production technologies of the specified winter season crops.
2. To quantify yield gaps between research, demonstration plots and farmers' plots in Lower Atbara area.
3. To enhance dissemination and scaling up processes of improved technologies by distribution of improved seeds to all trained farmers.
4. To improve farmers' income and livelihood by adopting improved technologies and by introducing new highly rewarding cash crops such as chickpea and common bean.

## (1)Wheat Demonstration Plots in Lower Atbara Area

### Materials and Methods:

Two contrasting improved wheat varieties namely, Nebta (early maturing) and Debeira (medium to late maturing) were planted in collaboration with four farmers in Lower Atbara area. Each variety was planted in an area of about 500 $m^2$ at each testing site. Two neighboring wheat farmer's plot was monitored for comparison purposes. Concurrently the two demonstrated wheat varieties were planted in a research-managed plot (750 $m^2$ per variety) at Hudeiba Research Farm as a reference site. In addition to the improved variety, the wheat improved production package consisted of:

1. Optimum planting date (during November).
2. Seeding rate of 140 kg/ha.
3. Fertilizer-N at a rate of 86 kg N/ha for Nebta and a fertilizer-N rate of 129kgN/ha for Debeira.
4. Fertilizer-P at a rate 43 kg $P_2O_5$ at the farm and on-station levels.
5. Frequent watering.
6. Weed management.

The crop management practices adopted in demonstration plots and neighboring farmers' plots in Lower Atbara; and in the reference site at Hudeiba Research Farm are presented in Table 1. In comparison to improved technology, the farmer's practice was generally characterized by absence of both phosphorous application and weed management, use of mixed crop varieties; comparatively delayed planting and use of low seed rates; and suboptimal application of irrigation water and fertilizer-N.

**Results and Discussion:**

The wheat crop grain yield performance in demonstration and neighboring farmers' plots in Lower Atbara Area as well as in the researcher-managed plot at Hudeiba Research Farm is presented in Table 1. The mean wheat crops yields ranged from a low of 1434kg/ha in the neighboring farmers' plots to a high of 3707kg/ha at farm level and a high of 3923kg/ha at the researcher-managed plots. The improved medium maturing variety Debeira gave the highest grain yields at both on-farm (3817kg/ha) and on-station (4097kg/ha) levels. Averaged over all varieties, the improved wheat production technology increased farmer's yield by 159% at the farm level and 174% at the researcher-managed plots level. These remarkable yield gaps were mainly attributed to use of mixed crop varieties; suboptimal application of irrigation water and fertilizers; absence of weed management; and comparatively delayed planting and in the neighboring farmers' plots (Table 1). To bridge these large yield gaps appreciable extension efforts are highly stressed.

**Economic Evaluation:**

The partial budget analysis technique was used for economic evaluation of improved wheat production technology (Table 2). The total wheat production costs were increased (82% at the farm level and 108% at the station level) by use of the improved technology (Table 2). However, the higher grain yields obtained with the adoption of improved technology had dramatically increased the net benefits over farmers' practice at both on-farm and on-station levels. Averaged over varieties, the farmer's net benefits were more than four-folds (410%) at the farm level, and were about four-folds (388%) when compared to the researcher-managed plots. Therefore the high costs associated with adoption of improved technology were more than compensated for by the high increments in grain yields obtained in response to adoption of improved technology. The evaluated improved wheat production technologies were highly profitable at both on-farm and on-station levels. The marginal rate of returns (MRR) ranged from a low of 99% (Nebta at reference site) to a high of 152% (Nebta and Debeira at the farm level) with an overall mean MRR of 152% at the farm level and 109% at the station level. Based on grain yield performance and economic

evaluation, at both on-farm and on-station levels, the medium maturing variety Debeira tended to be comparatively superior.

**(2) Faba Bean Demonstration Plots in Lower Atbara Area**

**Materials and Methods:**

The improved faba bean varieties Ed Damer and Hudeiba93 were planted in collaboration with four faba bean growers in Lower Atbara area. Each variety was planted in an area of about 500 $m^2$ at each testing site. One neighboring farmer's plot was monitored for comparison purposes. Concurrently the two investigated faba bean varieties were planted in a research-managed plot (500 $m^2$ per variety) at Hudeiba Research Farm as a reference site. In addition to the improved variety, the faba bean improved production technology comprized:

1. Optimum planting date (during November).
2. Seeding rate of 119 kg/ha.
3. Chemical weed control (Pursuit + Stomp).
4. Frequent watering.

The crop management practices followed in participating farmers' plots (PF), neighboring farmers' plots (NF) and reference site at Hudeiba Research Farm are presented in Table 3. The farmer's practice was generally characterized by use of local low yielding land race, absence of weed management and application of less irrigation water.

**Results and Discussion:**

The grain yield performance of faba bean crops in neighboring and participating farmers' plots in Lower Atbara Area, as well as in the reference site at Hudeiba Research Farm are displayed in Table 3. Mean faba bean grain yields ranged from a low of 1337 kg/ha in neighboring farmer's plot to a maximum of 1640 kg/ha in participating farmers' plots and a maximum of 1826 kg/ha in the reference site at Hudeiba Research Farm. Averaged over varieties, use of improved technology had increased farmer's yield by 23% at the farm level and by 37% as compared to the researcher-managed plot (Table 3). The grain yields of the two demonstrated faba bean varieties were similar at the farm level. However, at the station level, the improved variety Ed Damer outyielded Hudeiba93 by 27%. Use of a low yielding land race, absence of weed management and application of less irrigation water were the major factors underlying the low faba bean yields in farmer's field. Again more extension efforts are needed to boost faba bean yields in Lower Atbara Area.

**Economic Evaluation:**

The partial budget analysis technique was used for economical evaluation of the improved faba bean production package in Lower Atbara Area (Table 4). Averaged over the two investigated varieties, use of improved technology had increased total farmer's costs by 25% at the farm level and 43% at the station level. However, the higher grain yields obtained with the use of improved technology had appreciably increased the net benefits over farmers' practice at both on-farm and on-station levels. Averaged over varieties, the farmer's net benefits were increased by 21% and 32% at the farm and station levels, respectively. This implies that the high costs incurred by using improved technology were more than compensated for by the high increments in grain yields obtained in response to adoption of improved technology. The investigated faba bean varieties proved to be profitable at both on-farm and on-station levels. Averaged over varieties, the MRR was 124% at the farm level and 109% at the on-station level. However, the improved variety Ed Damer proved to be economically superior at both on-farm and on-station levels. Based on grain yield performance and economic evaluation, the improved variety Ed Damer proved to be superior at both on-farm and on-station levels.

**(3) Common Bean Demonstration Plots in Lower Atbara Area**

**Materials and Methods:**

Two improved common bean varieties namely, Ibberria (erect and large-seeded type) and RO/2/1 (prostrate and small-seeded type) were planted in collaboration with four farmers in Lower Atbara area. Each variety was planted in an area of about 500 $m^2$ at each testing site. Concurrently the two evaluated common bean varieties were planted in a research-managed plot (500 $m^2$ per variety) at Hudeiba Research Farm as a reference site. In addition to the improved variety, the common bean improved production technology included:

(1) Optimum planting date (early November).
(2) Seeding rate of 60 kg/ha for RO/2/1 and 80kg/ha for Ibberria.
(3) Chemical weed control (Pursuit + Stomp).
(4) Frequent watering.

The cultural practices adopted in at the on-farm and on-station levels are presented in Table 5. The low number of irrigations applied at the station level was mainly related to use of long-furrow irrigation (i.e. addition of more irrigation water).

**Results and Discussion:**

The grain yield performance of common bean crops in participating farmers' plots in Lower Atbara Area, as well as in the researcher-managed plots at Hudeiba Research Farm is shown in Table 5. The mean common bean yields ranged from a low of 1951 kg/ha (Ibberria at the farm level) to a maximum of 2647 kg/ha (RO/2/1 at the station level). Averaged over all varieties, the researcher-managed plots outyielded participating farmers' plots by 21%. This yield gap was mainly related to better crop establishment and proper weed management in the researcher-managed plots at

Hudeiba. The indeterminate, prostrate and small-seeded type variety (RO/2/1) proved to be superior at both on-farm and on-station levels. RO/2/1 outyielded Ibberria by 13% and 10% at the farm and station levels, respectively (Table 5).

**Economic Evaluation:**

The total production costs and net benefits were calculated for the two demonstrated common bean varieties (Ibberria and RO/2/1) at the farm (Lower Atbara Area) and research (Hudeiba Research Farm) levels (Table 6). The two demonstrated common bean varieties proved to be highly profitable at both the on-farm and on-station levels. The net returns ranged from a low of 14080 Ls/ha (Ibberria in Lower Atbara Area) to a maximum of 20247 Ls/ha at Hudeiba Research Farm. The improved variety RO/2/1 proved to be economically superior at both on-farm and on-station levels as evident in the calculated net benefits (Table 6). Based on economic evaluation and grain yield performance, the improved variety RO/2/1 proved to have high potential as a winter season cash crop in Lower Atbara Area.

**(4) Introduction of chickpea crop into Lower Atbara Area**

**Materials and Methods:**

Two contrasting improved chickpea varieties namely, Wad Hamid (early maturing) and Borgeig (late maturing) were planted in collaboration with four farmers in Lower Atbara Area. Each variety was planted in an area of about 500 $m^2$. Concurrently the same varieties were planted in researcher-managed plots (500$m^2$) at Hudeiba Research Farm. In addition to improved variety, the chickpea improved production package consisted of:

1. Optimum planting date (mid November).
2. Seeding rate of 80 kg/ha (Wad Hamid) and 70 kg/ha (Borgeig).
3. N-fertilizer at a rate of 86 kgN/ha.
4. Pest management.

The crop management practices adopted in demonstration plots in Lower Atbara Area and in the researcher-managed plot at Hudeiba Research Farm are presented in Table 7.

**Results and Discussion:**

The chickpea grain yields obtained in the participating farmers' plots in Lower Atbara and in the reference site at Hudeiba Research Farm are presented in Table 7. The mean chickpea yields ranged from a low of 1990 kg/ha (Borgeig at the farm level) to a maximum of 3313 kg/ha (Wad Hamid at the station level). Averaged over all varieties, the researcher-managed plots outyielded participating farmers' plots by 31%. This yield gap was mainly related to better crop establishment and proper weed management in the researcher-managed plots at Hudeiba. The early maturing variety Wad Hamid outyielded the late maturing one Borgeig at both on-farm (14%) and on-station (45%) levels (Table 7).

**Economic Evaluation:**

The total production costs and net benefits were calculated for the two demonstrated chickpea varieties Wad Hamid and Borgeig at the farm (Lower Atbara Area) and research (Hudeiba Research Farm) levels (Table 8). The two demonstrated chickpea varieties proved to be economically profitable at both the on-farm and on-station levels. The net returns ranged from a low of 2756 Ls/ha (Borgeig in Lower Atbara Area) to a maximum of 6373 Ls/ha at Hudeiba Research Farm. The improved early maturing variety Wad Hamid proved to be economically superior at both on-farm and on-station levels as evident in the calculated net benefits (Table 6). Based on economic evaluation and grain yield performance, the improved variety Wad Hamid tended to have high potential as a winter season cash crop in Lower Atbara Area.

**(5) Farmers' Field Days:**

Farmers in vicinity of testing sites as well as those distant from testing sites, but under IFAD mandate, were exposed to improved technologies during field days activities at both on-farm and on-station levels. Two farmers' Field days were organized in close collaboration with IFAD team in Lower Atbara Area. About 70 farmers participated in the field day activities. Participants were exposed and introduced to the different components of the improved production technology for each of the specified four crops. Concurrently extension pamphlets were distributed to participating farmers as well as other interested participants. Field days were also attended by IFAD team, extension officers and research scientists.

For scaling-up purposes, small seed lots (8 to 15 kg) from the reference site (intended to plant an area of 1000 $m^2$ for each crop) were packed and stored at Hudeiba. The seed lots are planned to be distributed by IFAD team (at planting time) to 60 trained farmers. Seeds to be distributed cover all demonstrated varieties of the four specified crops. Detailed extension pamphlets will distributed to participating farmers. The fate of seeds distributed to farmers will be monitored in collaboration with IFAD team in Lower Atbara Area.

Table (1): Grain yield and agronomic practices of wheat crops adopted at the farm (Lower Atbara) and the on-station (Hudeib Research Farm) levels during 2014/15 crop season.

| Farmer's No. | Variety | Plot area ($m^2$) | Planting date | Seed rate (kg/ha) | Weed Control | Fertilizer kgN/ha ($kgP_2O_5$) | No. of Irrigations | Grain Yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| **(a) Neighboring Farmers' Plots (Lower Atbara)** | | | | | | | | |
| **Mean** *(2 farmers)* | Mixed | **9800** | **21 Nov.** | **107** | **0** | **70(0)** | **7** | **1434** |
| **(b) Participating Farmers' Plots (Lower Atbara)** | | | | | | | | |
| Albiara-I | Nebta | 500 | 17Nov. | 140 | T+24D(1S) | 107.5(43) | 10 | 4072 |
| Albiara-II | Nebta | 500 | 15 Nov. | 140 | 0 | 107.5(43) | 11 | 3600 |
| Gangari | Nebta | 500 | 17 Nov. | 140 | T+24D(1S) | 107.5(43) | 11 | 3183 |
| Algilaia | Nebta | 500 | 15 Nov. | 140 | T+24D(1S) | 107.5(43) | 10 | 3533 |
| **Mean** | | **500** | **16 Nov.** | **140** | **T+24D(0.75S)** | **107.5(43)** | **10.5** | **3597** |
| Albiara-I | Debeira | 500 | 17Nov. | 140 | T+24D(1S) | 129(43) | 10 | 4221 |
| Albiara-II | Debeira | 500 | 15 Nov. | 140 | 0 | 129(43) | 11 | 3879 |
| Gangari | Debeira | 500 | 17 Nov. | 140 | T+24D(1S) | 129(43) | 11 | 4413 |
| Algilaia | Debeira | 500 | 15 Nov. | 140 | T+24D(1S) | 129(43) | 10 | 2754 |
| **Mean** | | **500** | **16 Nov.** | **140** | **T+24D(0.75S)** | **129(43)** | **10.5** | **3817** |
| | | | | | | | | |
| **Grand Mean** | | **500** | **16 Nov.** | **140** | **T+24D(0.75S)** | **118.2(43)** | **10.5** | **3707** |
| **(c) Reference Site (Hudeiba Research Farm)** | | | | | | | | |
| On-Station | Nebta | 750 | 13 Nov. | 140 | T+24D(1S) | 129(43) | 9 | 3749 |
| On-Station | Debeira | 750 | 13 Nov. | 140 | T+24D(1S) | 129(43) | 10 | 4097 |
| **Mean** | | **750** | **13 Nov.** | **140** | **T+24D(1S)** | **129(43)** | **9.5** | **3923** |

*Notice: T = Traxos, 24D = Post emergence application of Dialine Super (2-4-D) and S = Spray.*

Table (2): Partial budget analysis for wheat demonstration plots in Lower Atbara Area 2014/2015 season.

| **Item** | **Reference Site (Hudeiba)** | | | **PF Plots (Lower Atbara)** | | | **NF Plots** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Variety | Nebta | Debeira | **Mean** | Nebta | Debeira | **Mean** | Mixed |
| Yield (kg/ha) | 3749 | 4097 | **3923** | 3597 | 3817 | **3707** | 1434 |
| Price (Ls/kg) | 3.5 | 3.5 | **3.5** | 3.5 | 3.5 | **3.5** | 3.5 |
| **Total Benefit (Ls/ha)** | **13122** | **14340** | **13731** | **12590** | **13360** | **12975** | **5019** |
| **Production Costs (Ls/ha):** | | | | | | | |
| Land Preparation | 1071 | 1071 | **1071** | 905 | 905 | **905** | 905 |
| Seeds | 840 | 840 | **840** | 840 | 840 | **840** | 492 |
| Fertilizers | 1817 | 1817 | **1817** | 1598 | 1817 | **1708** | 724 |
| Irrigation | 563 | 625 | **594** | 656 | 656 | **656** | 438 |
| Weed Control | 928 | 928 | **928** | 697 | 697 | **697** | 0 |
| Harvest | 2690 | 2829 | **2760** | 2153 | 2241 | **2197** | 1288 |
| **Total Cost (Ls/ha)** | **7909** | **8110** | **8010** | **6849** | **7156** | **7002** | **3847** |
| **Net Benefit (Ls/ha)** | **5213** | **6230** | **5721** | **5741** | **6204** | **5973** | **1172** |
| **MRR (%)** | **99** | **119** | **109** | **152** | **152** | **152** | |

*Notice: PF = Participating farmers' plots and NF = Neighboring farmers' plots.*

Table (3): Grain yield and cultural practices of faba bean crops adopted at the farm (Lower Atbara) and the on-station (Hudeib Research Farm) levels during 2014/15 crop season.

| Farmer's No. | Variety | Plot area ($m^2$) | Planting date | Seed rate (kg/ha) | Weed Control | No. of Irrigations | Grain Yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| **(a) Neighboring Farmers' Plots (Lower Atbara)** | | | | | | | |
| *(1 farmer)* | local | **6300** | **9 Nov.** | **143** | **0** | **6** | **1337** |
| **(b) Participating Farmers' Plots (Lower Atbara)** | | | | | | | |
| Albiara-I | Ed Damer | 500 | 3Nov. | 119 | P+Stomp (1S) | 10 | 1701 |
| Albiara-II | Ed Damer | 500 | 3Nov. | 119 | P+Stomp (1S) | 10 | 1781 |
| Gangari | Ed Damer | 500 | 3 Nov. | 119 | P+Stomp (1S) | 10 | 1142 |
| Algilaia | Ed Damer | 500 | 8 Nov. | 119 | P+Stomp (1S) | 10 | 2051 |
| **Mean** | | **500** | **4Nov.** | **119** | **P+Stomp (1S)** | **10** | **1669** |
| Albiara-I | Hudeiba93 | 500 | 3Nov. | 119 | P+Stomp (1S) | 10 | 1789 |
| Albiara-II | Hudeiba93 | 500 | 3Nov. | 119 | P+Stomp (1S) | 10 | 1744 |
| Gangari | Hudeiba93 | 500 | 3 Nov. | 119 | P+Stomp (1S) | 10 | 1050 |
| Algilaia | Hudeiba93 | 500 | 8 Nov. | 119 | P+Stomp (1S) | 10 | 1862 |
| **Mean** | | **500** | **4Nov.** | **119** | **P+Stomp (1S)** | **10** | **1611** |
| | | | | | | | |
| **Grand Mean** | | **500** | **4Nov.** | **119** | **P+Stomp (1S)** | **10** | **1640** |
| **(c) Reference Site (Hudeiba Research Farm)** | | | | | | | |
| On-Station | Ed Damer | 500 | 31 Oct. | 119 | P+Stomp (1S) | 9 | 2041 |
| On-Station | Hudeiba93 | 500 | 31 Oct. | 119 | P+Stomp (1S) | 9 | 1610 |
| **Mean** | | **500** | **31 Oct.** | **119** | **P+Stomp (1S)** | **9** | **1826** |

*Notice: P+Stomp = Pre-emergence application of in-tank mixture of Pursuit and Stomp and S = Spray.*

Table (4): Partial budget analysis for faba bean demonstration plots in Lower Atbara Area 2014/2015 season.

| **Item** | **Reference Site (Hudeiba)** | | | **PF Plots (Lower Atbara)** | | | **NF Plots** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Variety | Ed Damer | Hudeiba93 | **Mean** | Ed Damer | Hudeiba93 | **Mean** | Local |
| Yield (kg/ha) | 2041 | 1610 | **1826** | 1669 | 1611 | **1640** | 1337 |
| Price (Ls/kg) | 7 | 7 | **7** | 7 | 7 | **7** | 7 |
| **Total Benefit (Ls/ha)** | **14287** | **11270** | **12778** | **11683** | **11277** | **11480** | **9359** |
| **Production Costs (Ls/ha):** | | | | | | | |
| Land Preparation | 1071 | 1071 | 1071 | 905 | 905 | 905 | 905 |
| Seeds | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1215 |
| Irrigation | 563 | 563 | 563 | 625 | 625 | 625 | 375 |
| Weed Control | 600 | 600 | 600 | 600 | 600 | 600 | 0 |
| Harvest | 2006 | 1834 | 1920 | 1382 | 1358 | 1370 | 1249 |
| **Total Cost (Ls/ha)** | **5430** | **5258** | **5344** | **4702** | **4678** | **4690** | **3744** |
| **Net Benefit (Ls/ha)** | **8857** | **6012** | **7434** | **6981** | **6599** | **6790** | **5615** |
| **MRR (%)** | **192** | **26** | **109** | **143** | **105** | **124** | |

*Notice: PF = Participating farmers' plots and NF = Neighboring farmer's plot.*

Table (5): Grain yield and cultural practices of common bean crops adopted at the farm (Lower Atbara) and the on-station (Hudeib Research Farm) levels during 2014/15 crop season.

| Farmer's No. | Variety | Plot area ($m^2$) | Planting date | Seed rate (kg/ha) | Weed Control | No. of Irrigations | Fertilizer (kgN/ha) | Grain Yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| **(a) Participating Farmers' Plots (Lower Atbara)** | | | | | | | | |
| Albiara-I | Ibberria | 500 | 3 Nov. | 80 | P+St(1S) | 10 | 86 | 1645 |
| Albiara-II | Ibberria | 500 | 3 Nov. | 80 | P+St(1S) | 11 | 86 | 2251 |
| Gangari | Ibberria | 500 | 3 Nov. | 80 | P+St(1S) | 10 | 86 | 1515 |
| Algilaia | Ibberria | 500 | 8 Nov. | 80 | P+St(1S) | 10 | 86 | 2394 |
| **Mean** | | **500** | **4 Nov.** | **80** | **P+St(1S)** | **10.25** | **86** | **1951** |
| Albiara-I | RO/2/1 | 500 | 3 Nov. | 60 | P+St(1S) | 10 | 86 | 2488 |
| Albiara-II | RO/2/1 | 500 | 3 Nov. | 60 | P+St(1S) | 11 | 86 | 1796 |
| Gangari | RO/2/1 | 500 | 3 Nov. | 60 | P+St(1S) | 10 | 86 | 1959 |
| Algilaia | RO/2/1 | 500 | 8 Nov. | 60 | P+St(1S) | 10 | 86 | 2611 |
| **Mean** | | **500** | **4 Nov.** | **60** | **P+St(1S)** | **10.25** | **86** | **2213** |
| | | | | | | | | |
| **Grand Mean** | | **500** | **4Nov.** | **70** | **P+St(1S)** | **10.25** | **86** | **2082** |
| **(b) Reference Site (Hudeiba Research Farm)** | | | | | | | | |
| On-Station | Ibberria | 500 | 1 Nov. | 80 | P+St(1S) + 1HW | 8 | 86 | 2411 |
| On-Station | RO/2/1 | 500 | 1 Nov. | 60 | P+St(1S) + 1HW | 8 | 86 | 2647 |
| **Mean** | | **500** | **1 Nov.** | **70** | **P+St(1S) + 1HW** | **8** | **86** | **2529** |

*Notice: P+St = Pre-emergence application of in-tank mixture of Pursuit and Stomp, S = Spray and HW = Hand weeding.*

Table (6): Production costs and benefits of common bean crops, demonstrated at the farm (Lower Atbara) and on-station (Hudeiba) levels during 2014/2015 crop season.

| Item | Reference Site (Hudeiba) | | | PF Plots (Lower Atbara) | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Variety | Ibberria | RO/2/1 | **Mean** | Ibberria | RO/2/1 | **Mean** |
| Yield (kg/ha) | 2411 | 2647 | **2529** | 1951 | 2213 | **2082** |
| Price (Ls/kg) | 10 | 10 | **10** | 10 | 10 | **10** |
| **Total Benefit (Ls/ha)** | **24110** | **26470** | **25290** | **19510** | **22130** | **20820** |
| **Production Costs (Ls/ha):** | | | | | | |
| Land Preparation | 1071 | 1071 | **1071** | 905 | 905 | **905** |
| Seeds | 900 | 675 | **788** | 900 | 675 | **788** |
| Fertilizers | 890 | 890 | **890** | 890 | 890 | **890** |
| Irrigation | 500 | 500 | **500** | 641 | 641 | **641** |
| Weed Control | 838 | 838 | **838** | 600 | 600 | **600** |
| Harvest | 2154 | 2249 | **2202** | 1494 | 1599 | **1546** |
| **Total Cost (Ls/ha)** | **6354** | **6223** | **6288** | **5430** | **5310** | **5370** |
| **Net Benefit (Ls/ha)** | **17756** | **20247** | **19002** | **14080** | **16820** | **15450** |

*Notice: PF = Participating farmers' plots.*

Table (7): Grain yield and cultural practices of chickpea crops adopted at the farm (Lower Atbara) and the on-station (Hudeib Research Farm) levels during 2014/15 crop season.

| Farmer's No. | Variety | Plot area ($m^2$) | Planting date | Seed rate (kg/ha) | Weed Control | No. of Irrigations | Fertilizer (kgN/ha) | Grain Yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| **(a) Participating Farmers' Plots (Lower Atbara)** | | | | | | | | |
| Albiara-I | Wad hamid | 500 | 11 Nov. | 80 | Goal (1S) | 10 | 86 | 2899 |
| Albiara-II | Wad hamid | 500 | 14 Nov. | 80 | Goal (1S) | 10 | 86 | 3734 |
| Gangari | Wad hamid | 500 | 11 Nov. | 80 | Goal (1S) | 10 | 86 | 555 |
| Algilaia | Wad hamid | 500 | 15Nov. | 80 | Goal (1S) | 10 | 86 | 1916 |
| **Mean** | | **500** | **13 Nov.** | **80** | **Goal (1S)** | **10** | **86** | **2276** |
| Albiara-I | Borgeig | 500 | 11 Nov. | 70 | Goal (1S) | 10 | 86 | 2363 |
| Albiara-II | Borgeig | 500 | 14 Nov. | 70 | Goal (1S) | 10 | 86 | 1692 |
| Gangari | Borgeig | 500 | 11 Nov. | 70 | Goal (1S) | 10 | 86 | 1371 |
| Algilaia | Borgeig | 500 | 15Nov. | 70 | Goal (1S) | 10 | 86 | 2534 |
| **Mean** | | **500** | **13 Nov.** | **70** | **Goal (1S)** | **10** | **86** | **1990** |
| | | | | | | | | |
| **Grand Mean** | | **500** | **13 Nov.** | **75** | **Goal (1S)** | **10** | **86** | **2133** |
| **(b) Reference Site (Hudeiba Research Farm)** | | | | | | | | |
| On-Station | Wad hamid | 500 | 15 Nov. | 80 | Goal (1S) + 1HW | 8 | 86 | 3313 |
| On-Station | Borgeig | 500 | 15 Nov. | 70 | Goal (1S) + 1HW | 9 | 86 | 2283 |
| **Mean** | | **500** | **15 Nov.** | **75** | **Goal (1S) + 1HW** | **8.5** | **86** | **2798** |

*Notice: S = Spray and HW = Hand weeding.*

Table (8): Production costs and benefits of chickpea crops, demonstrated at the farm (Lower Atbara) and on-station (Hudeiba) levels during 2014/2015 crop season.

| Item | Reference Site (Hudeiba) | | | PF Plots (Lower Atbara) | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Variety | Wad Hamid | Borgeig | **Mean** | Wad Hamid | Borgeig | **Mean** |
| Yield (kg/ha) | 3313 | 2283 | **2798** | 2276 | 1990 | **2133** |
| Price (Ls/kg) | 3.75 | 3.75 | **3.75** | 3.75 | 3.75 | **3.75** |
| **Total Benefit (Ls/ha)** | **12424** | **8561** | **10492** | **8535** | **7463** | **7999** |
| **Production Costs (Ls/ha):** | | | | | | |
| Land Preparation | 1071 | 1071 | **1071** | 905 | 905 | **905** |
| Seeds | 480 | 420 | **450** | 480 | 420 | **450** |
| Fertilizers | 890 | 890 | **890** | 890 | 890 | **890** |
| Irrigation | 500 | 563 | **532** | 625 | 625 | **625** |
| Weed Control | 595 | 595 | **595** | 357 | 357 | **357** |
| Harvest | 2515 | 2103 | **2309** | 1624 | 1510 | **1567** |
| **Total Cost (Ls/ha)** | **6051** | **5642** | **5846** | **4881** | **4707** | **4794** |
| **Net Benefit (Ls/ha)** | **6373** | **2919** | **4646** | **3654** | **2756** | **3205** |

*Notice: PF = Participating farmers' plots.*

**Activity 2: Water saving technologies (pipe conveyance system)**

**Scientists in charge: Prof. Mekki Abdelateef**

**Dr. Waleed Mohamed Alamin**

**Water Harvesting Research Institute (WHRI)**

**Final report (season 2014 - 2015)**

## Introduction:

Preceding to field test and verification of four irrigation systems demos (drip, bubbler, pipe conveyance and sprinkler) at Lower Atbara, and evaluation; pipe conveyance system emerged to be the most likely desired by producers. It is cheap, simple and easy to install and operate. On the basis of such outcomes a joint meeting of the project staff, DG of ARC and ICARDA back stopping team on September 2014 has recommended installing 6 more units of pipe conveyance for promotion and up-scaling of the system within the IFAD – Butana Integrated Rural Development Project (BIRDP) supported communities. Accordingly, the Water Harvesting Research Institute (WHRI) and IFAD coordination office at EdDamar were requested to perform field survey and communities sensitization for selection of appropriate sites and interested farmers for installation of the 6 units, each covering one feddan area. Table 1 below shows the selected participating farmers in two communities with cropping pattern for the demo's activities.

**Table 1: Farmers selected for promotion of pipe conveyance system in AlAbaar and Gangari communities**

| Village/ community | Participating Farmer | Cropping pattern |
|---|---|---|
| AlAbaar | Rahmitalla | Okra |
| " " | Elhadi | Okra |
| | Yassin | Alfa alfa |
| " " | Marighani Musa | Wheat/okra |
| Gangari | Shwagi | Okra |
| " " | AbassElbaih | Wheat |

## Objective of demo farm interventions

To introduce pipe conveyance system to new farmers to witness economic, irrigation water savings and crop yield improvement and enhancing adoption.

**Monitoring and data collection:**

The WHRI engineers have conducted regular visits for follow up and check for repair and maintenance needs and operation and management (O&M) issues. On-farm training to producers on O&M has been exercised and implemented. Likewise regularly monitoring and follow up of field measurement and data collection pertaining to performance indicators was collectively performed by the BIRDP extension agents the institute technicians. The indicators of concern to the technology performance are the following:

- Fuel consumption or electricity use and cost recording
- Irrigation water use
- Irrigation labor and weeding labor (man days and cost)
- Irrigation time of pumping unit (hr)
- Crop yield

**Result and Discussion:**

**Water savings and other benefits:**

Analysis of demo farms water savings data (table 2) indicates that the pipes conveyance (PC) produced 14 – 30 % water savings over the traditional open channel and flood irrigation practices under vegetables (okra) and field crop (wheat). The tables also indicate that the savings did vary for the improved pipes conveyance plots, depending on the seepage losses from the unlined open channels. In addition, to the irrigation water savings, also benefits in fuel, pumping hours and labor savings and increase in crop yields were observed. The percentage increase figures under the improved pipes conveyance are 14 - 30 % for fuel, 14.5 - 30 % for the pump irrigation time and 30 - 71 % labor savings. The water savings may be attributed to reducing seepage losses from the unlined open channels.

The variation in the obtained results may probably reflects the effect of soils, cropping patterns, length of growing season and farmers experience as well as to that soils variability between areas close to the river and those in the upper-terrace, which is generally light. The labor requirements on this table are the labor working hours used in the irrigation operation. It consists of labor time used in operating and closing of the pump units and control valves, weeding and trimming of grasses in irrigation channels, in comparison to manual intensive labour requirements under the traditional practices such as digging and removal of soil during follow of irrigation process in general.

**Table 2: Water savings and other benefits in demo farms**

| | **Community** | **Crop** | **Percent savings (%)** |
|---|---|---|---|

| Name of the Participating Farmer | | | Water | Fuel | Pump operation time | Labor |
|---|---|---|---|---|---|---|
| Shawgi Eltayb Babikr | Gangari | Okra | 14 | 14 | 25 | 30 |
| Margani Musa | AlAbaar | Wheat | 17 | 17 | 23 | 23 |
| Rahmtalla Ahmed Elbasher | AlAbaar | Okra | 14 | 14 | 14.5 | 92 |
| Abas Fadlalla | Gangari | Wheat | 30 | 30 | 30 | 71 |
| **Average** | | | **19** | **19** | **23** | **54** |

**Crop yield:**

Table 3 shows the results of crop productivity under the improved pipe conveyance of the demo farms compared with traditional practice with open channels. Generally, the demo farms with improved pipe conveyance system out-yielded the traditional irrigation system by about 20%. Crop yield data for wheat showed slight increase above the average, whereas the okra yield increased by 21 % for two farmers.

**Table 3: Crop yield under pipe conveyance and traditional irrigation systems**

| Name of the Participating Farmer . | Crop | Yield (ton/fed) | | % increase |
|---|---|---|---|---|
| | | Pipe conveyance | Traditional | |
| Shawgi Eltayb Babikr | Okra | 3.37 | 2.68 | 21 |
| Margani Musa | Wheat | 0. 8 | 0.65 | 23 |
| Rahmtalla Ahmed Elbash | Okra | 2.13 | 1.91 | 12 |
| Abas Fadlalla | Wheat | 1.15 | 0.95 | 21 |

**Table 4. Cost benefit analysis**

| Name of the Participating Farmer . | crop | Cost of production (SDG) | | Returns (SDG) | | Net benefits (SDG) | |
|---|---|---|---|---|---|---|---|
| | | Improved pipe conveyance system | Traditional irrigation system | Improved pipe conveyance system | Traditional irrigation system | Improved pipe conveyance system | Traditional irrigation system |
| Shawgi Eltayb Babikr | Okra | 2380 | 2876 | 11004 | 9612 | 8624 | 6736 |
| Margani Musa | Wheat | 2361 | 2532 | 4300 | 2900 | 2039 | 368 |
| Rahmtalla Ahmed Elbasher | Okra | 2906 | 3476 | 8176 | 7662 | 5270 | 4126 |
| Abas Fadlalla | Wheat | 2564 | 2450 | 5650 | 4050 | 3086 | 1600 |

**Way forward:**

The up scaling of the pipe conveyance system among the project beneficiaries depends on access to credit and communities interest. Meeting at the Federal level with the Sudan Rural Development Company indicates availability of credit and arrangements are necessary for conducting field surveys for assessment of community response and volume of credit. Primary the company agreed to undertake 3 communities for survey work and assessment during August 2015.

**Okra under the pipe conveyance system at AlAbaar village in Lower Atbara River**

**Wheat under the pipe conveyance system at Gangari village in Lower Atbara River**


The field day event, Lower Atbara River

The field day event, Lower Atbara River

**Activity 3: Livestock production**

**Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry land Areas**

**Range-Livestock Annual Technical Report (2015)**

**Faisal M El-Hag, Research Professor (Range-Livestock), ARC-DLRC**

## 1. General Introduction

The project "Integrated Agricultural Production Systems for the Poor and Vulnerable in Dry land Areas" targets the poor and vulnerable populations of the dry areas and aims at developing technology, policy and institutional innovations to improve livelihoods, using an integrated systems approach. In Sudan, the project activities are implemented at Lower Atbara region in the River Nile State, that has been identified by the Sudan National Adaptation Program of Action (NAPA, 2007) as one of the main areas in the country as particularly vulnerable to climate change. The area falls with a semi desert zone, characterized by increased temperature and accelerated desert encouragement with increased land degradation. Some of the impact could be seen in deficiency in major elements (particularly P, Ca and Iodine) (El-Hag *et al*. 2011) as reflected in reduced crop yields and low livestock productivity. Previous ICARD activities in the area under the phase I project; "Improving the livelihoods of rural communities in the Nile Valley and Sub Saharan African Region: Sustainable crop and livestock management", has identified water conveyance as a platform for technological innovations under the smallholder integrated farming systems in the area. This platform could be scaled-up to improve productivity, and enhance rural communities' resilience and build their capacity to adapt to climate change, hence managing risk and improving productivity.

Livestock raised under these smallholder integrated traditional production systems depends mainly on crop residues and to a limited extent on meager rangelands resources in Lowe Atbara region. The impact of climate change on livestock productivity could be seen in reduced milk yields, low fertility and reduced reproductive rates (El-Hag et al., 2001) and high mortality in both young and adult animals. Livestock activities focused on utilization forages and crop residues produced under water conveyance platform together with necessary supplements to improve productivity and milk yields for smallholder animals particularly during the dry season.

The project activities started in early February 2015 for lactating goats and cows, and for breeding sheep flocks. Project activities covered two villages. Activities conducted were:

- Concentrates and saltlick blocks for lactating animals (goats, cows) to improve milk yields and household food security
- Supplementary feeding activities for lactating goats targeted women farmers in the area whereas those for lactating cows and breeding sheep covered two villages. Feed resources produced under water conveyance platform used included forage legumes clitoria or Berseem hay on a basal diet of sorghum and wheat straw. Other feed resources used included oilseed cakes and saltlick blocks.
- Strategic supplementary feeding for breeding ewes for improving reproductive performance.

## 2. Supplementation to Lactating Animals

**Introduction:** Protein concentrates and mineral supplementation trials for lactating goats were conducted at two villages (El Abar and El Goba) at lower Atbara. For lactating cows, groundnut seed cake (GNSC) and saltlick were used. However, for lactating cows there were only 17 lactating cows at the two villages. Only 14 cows were included into this activity, nine supplemented and

five were used as a control and their data were analyzed collectively as a RCBD. Range plants and crops residues in the area are deficient in major mineral elements, particularly phosphorus and calcium. The objectives were to improve milk yield at these areas in order to improve supply of milk for the inhabitants particularly children and women, and other objectives was to improve goats and cows fertility.

**Methodology**

**Lactating goats' trials:** The trials were conducted during the dry summer season (March-June) of 2015. Lactating goats at the two villages at lower Atbara (El Abar and El Goba Villages) were included in these trials. A total number of 120 lactating goats (2-4 years old), belonging to 25 women farmers were used in these trials (Table 1). Goats in lower Atbara are a mixture of Desert and Nubian goat subtypes. Desert goats are characterized with low milk yields and lower body weight, but are prolific with a twining rate of about 30.0% whereas Nubian goats are known for their high milk yields ranging from 2.5-3.5 litre/day. At each village, goats belonging to each farmer were randomly either supplemented (legume hay + Saltlick) or left as control (Ivomec Injection only).

The legume hay quantity provided for each goat was 400 g daily, while a saltlick block was hanged at goats barns. All goat groups, including control goats, were initially injected with Ivomec (Ivomectin$^{R}$) as a prophylactic treatment against internal and external parasites administered at 0.5 cc s/c, and repeated two weeks later. The trials lasted for 6 weeks (42 days).

**Lactating cows' trials:** The second trial utilized fourteen (14) lactating cows at the two villages (Table 1). The cows at lower Atbara belong to Butana breed; a *Bos indicus* (Zebu) cattle reputed for their milk yields (10-15 litre/cow/day). All cows were 8-10 years old, belonging to 14 farmers. Nine cows were randomly assigned to the supplementary feeding treatment while the other five were left as a control, same as goats, but for lactating cows GNSC was used instead of the legume hay. GNSC quantity provided for each cow was 250 g daily and the Ivomec was injected at 5.0 cc s/c per cow repeated after two weeks. Mineral supplementation for lactating cows was done through hanging a brick of saltlick at the animal barns throughout the trial period. Cows were at the 2$^{nd}$ month of their lactation period. The basal diet was wheat and Abu 70 straws mixed on equal proportions and provided *ad libitum*. The trials lasted for 6 weeks (42 days) during the period March-June 2015.

All animals (cows or goats) were first allowed an adaptation period of one week before the full provision of the allotted supplement quantity. Data recorded was mainly daily milk yields and the animals were observed for services and conception. The farmers (men and women) were provided with notebooks and pens to keep the daily milk yield records of their animals.

**Strategic supplementary feeding of breeding ewes:** A total of 40 ewes were used in this trial, 20 at each of the village (El Abar and El Goba). The ewes were 4-5 years old. At each village the ewes were divided into two groups, one received 400 g/ewe/day for one month at breeding time and a month prior to lambing while the other was left as a control (farmer practice), with saltlick provided as mineral blocks hanged at resting areas. Breeding rams were also supplemented with the same forage legume hay during the mating time. All ewes and rams received a prophylactic treatment against internal and external parasites.

**Economic analyses:** Costs of supplements (legume hay, GNSC and saltlick) were given. Cost-benefit analysis was also carried out to delineate cost per liter of milk produced for both lactating goats and lactating cows. A partial budgeting was done for the economic analysis of breeding ewes performance.

Table 1. Participants farmers by gender, total animals and lactating animals included in trials.

| Activity | Village | Animals | Women | Men | Total |
|---|---|---|---|---|---|
| Supplementary feeding of lactating goats | Al Abar | 60 | 12 | 0 | 12 |
| | El Goba | 60 | 13 | 0 | 13 |
| Supplementary feeding of lactating cows | Al Abar | 9 | 0 | 7 | 7 |
| Strategic supplementary feeding of breeding ewes | El Abar | 20 | 0 | 1 | 1 |
| | El Goba | 20 | 2 | 2 | 4 |
| **Participant farmers:** | | | | | |
| Women | 27 | | | | |
| Men | 10 | | | | |
| **Animals:** | | | | | |
| Lactating Goats | 120 | | | | |
| Breeding Ewes | 40 | | | | |
| Lactating Cows | 9 | | | | |

**Results**

**Lactating goats:** Supplementary feeding of lactating goats with legume hay and saltlick blocks had increased (P<0.001) total and daily milk yields (Table 2). The percentage increases in average daily milk yield of supplemented goats over the controls was 58.6%. The economic analysis for lactating goats resulted in higher returns compared with un-supplemented controls (Table 3). Percentage increase in returns from milk of supplemented goats over that of the controls was 55.7%. The marginal rate of return (MRR) was derived as the ratio of marginal net benefit to the related marginal cost of the supplemented (treated) goats and was calculated as 622% (Table 4). This result meant that every monetary unit (1 SDG) invested would be returned, plus earning an additional amount of 6 SDG This implied that goats at Lower Atbara villages could be supplemented with forage legumes + saltlick blocks.

Table 2. Effect of mineral and concentrate supplementation on milk yield of lactating goats at Lower Atbara villages

| Parameter | Legume Hay + Saltlick | Control | SE± |
|---|---|---|---|
| **Lactating Goats:** | | | |
| No. of goats | 120 | 40 | |
| Weeks on test | 7 | 7 | |
| Average total goat milk yield (litre) | 88.50 | 53.75 | 3.507** |
| Average daily milk yield/goat (litre) | 2.11 | 1.33 | 0.081** |
| %Increase over control goats | 58.6% | | |

*** = very highly significant (P<0.001).

Table 3. Lactating goat feed supplement quantities (kg), costs and returns from milk yield (sdg*)

| Parameter | Concentrate + Saltlick | Control |
|---|---|---|
| No. of goats | 120 | 40 |
| Days on test | 42 | 42 |
| **Supplements per goat:** | | |
| Legume hay (g/goat/day) | 400.0 | 0 |
| Legume had (kg/goat/42 days) | 16.8 | 0 |
| Legume hay for the whole group (kg) | 2,016 | 0 |
| Legume hay cost (sdg/kg) | 1.4 | 0 |
| **Legume hay total cost per flock (sdg)** | **2,822.4** | **0** |
| **Legume hay total cost per goat (sdg)** | **23.52** | |
| Saltlick block (g/goat/day) | 5.0 | 0 |
| Saltlick total consumption (kg) | 2.52 | 0 |
| Saltlick unit cost (sdg/kg) | 5 | 0 |
| Saltlick total cost (sdg) | 12.6 | 0 |
| **Total costs per goat (sdg)** | **36.12** | **0** |
| **Benefits:** | | |
| Av. total Milk yield per goat (litre) | 88.50 | 53.75 |
| Milk price (sdg/litre) | 7.50 | 7.50 |
| **Total milk revenue (sdg)** | **663.75** | **403.125** |
| **Returns (Revenue-Costs) (sdg)** | **627.63** | **403.125** |
| **Increase in returns over controls (%)** | **55.7** | |
| **MRR (%)** | **622** | |

- Sudanese Pound

**Lactating cows:** Supplementary feeding of lactating cows with concentrates and saltlick blocks had, also, increased ($P<0.001$) their total and daily milk yields (Table 4). The percentage increase in average daily milk yield of lactating cows supplemented with concentrates + saltlick over that of the control cows was 40.9%. The highest returns were recorded for lactating cows supplemented with GNSC + Saltlick and the lowest were for the controls. Percentage increase in returns from milk of supplemented cows over that of the controls was 23.8%. The treatment was highly profitable as shown by the high MRR (1547%), which meant that every monetary unit (1 SDG) invested in the supplementary feeding of lactating cows, would be recovered plus earning an additional amount of about 15 SDG (Table 5).

Table 4. Effect of mineral and concentrate supplementation on milk yield of lactating cows at Lower Atbara villages

| Parameter | Concentrate + Saltlick | Control | SE± |
|---|---|---|---|
| **Lactating Cows:** | | | |
| No. of cows | 9 | 5 | |
| Weeks on test | 6 | 6 | |
| Milk Yield (litre/cow): | | | |
| Average total cow milk yield | 515.088 | 304.500 | 22.237*** |
| Average daily milk yield/cow | 12.264 | 7.25 | 0.765** |
| %Increase over control cows | 40.9% | -- | |

*** = very highly significant (P<0.001).

Table 5. Lactating cow feed supplement quantities (kg), costs and returns from milk yield (sdg)

| Parameter | Conc.+Saltlick | Control |
|---|---|---|
| No. of cows | 9 | 5 |
| Days on test | 42 | 42 |
| Supplements: | | |
| GNSC (g/cow/day) | 250 | 0 |
| GNSC (g/cow/42 days) (kg) | 10.5 | 0 |
| GNSC for the whole group (kg) | 94.50 | 0 |
| GNSC unit cost (sdg) | 1.75 | |
| GNSC total cost per cow (sdg) | 18.375 | 0 |
| Saltlick block (g/cow/day) | 80 | 0 |
| Saltlick total consumption (kg/group) | 30.24 | 0 |
| Saltlick consumption per cow (kg) | 3.36 | |
| Saltlick unit cost (sdg/kg) | 5 | 0 |
| Saltlick total costs per cow (sdg) | 16.8 | 0 |
| **Total supplements costs per cow (sdg)** | **35.175** | **0** |
| **Benefits:** | | |
| Total Milk yield (litre) | 515.088 | 304.500 |
| Milk price (sdg/litre) | 7.50 | 7.50 |
| **Total milk revenue (sdg)** | **3,863.16** | **2,283.75** |
| **Returns (Revenue-Costs) (sdg)** | 2,828.01 | 2,283.75 |
| **Increase in returns over controls (%)** | 23.8% | |
| **MRR (%)** | 1547 | |

### 3. Strategic supplementary feeding of breeding ewes

**Introduction:** At Lower Atbara, sheep production is practiced under traditional smallholder farming systems characterized by low inputs and extensive mode of production. Sheep breeding (mating) is controlled to be done at February-March to coincide lambing with July-August to match lambing with rainy season and availability of feed resources. This practice subjects breeding stock to nutritional stress and results in low conception and lambing rates, and high abortion and ewe and lamb mortality rates (El-Hag et al., 2001). The objective was to improve desert sheep reproductive performance in order to increase smallholder farmer income.

**Materials and Methods:** This trial was conducted at two villages. Forty ewes (3-4 years old), twenty at each village, were used. At each village, the ewes were divided in two equal groups of 10 heads each. One group was randomly assigned to forage legume + saltlick supplementation while the other was left as a control. Forage legume hay (clitoria + berseem) was supplemented at 400 g/head/day. Ewes in both groups had free access to saltlick at resting areas. The ewes were offered the supplement in small groups during the watering time (every three days). Supplementation for one month before mating time, then stopped and resumed again at the last trimester of the gestation period (one month before lambing). Breeding rams (2 desert rams, 5 years old) were offered a supplement of forage legume hay only at mating time and were rotated between the two ewe groups to eliminate ram-to-ram effect. Ewes were monitored for behavioral estrous signs and were serviced accordingly. Data collected included number of ewes serviced, abortions, mortality, lambing, and lamb type of birth.

**Results:** Conception rates ranged from 90.0% for forage legume supplemented ewes to 50.0% for the control group. No abortions or mortalities were recorded for both groups (Table 6). From these results, it appeared that forage legumes (clitoria, berseem hay) could be used to supplement desert ewes to improve their productivity. Partial budgeting showed that increase of return of supplemented ewes over the control was about 101% and the increase in cost was only about 11%. The strategic supplementary feeding of breeding ewes with forage legumes was highly profitable as indicated by the high MRR of about 1060% (Table 6).

Table 6. Desert sheep reproductive performance at lower Atbara in response to strategic supplementary feeding together with partial budget for strategically supplemented and control ewes (prices in sdg)

| **Parameter** | **Cowpea Group** | **Control group** |
|---|---|---|
| No. ewes | 20 | 20 |
| No. conceived | 18 (90.0%) | 10 (50.0%) |
| Not conceived | 2 (20.0%) | 10 (50.0%) |
| No. lambed | 18 (90.0%) | 10 (50.0%) |
| **Type of birth:** | | |
| Single births | 10 | 7 |
| Twin births | 8 | 3 |
| Total number of lambs | 26 | 13 |
| Ewe costs (sdg) | 6,000.00 | 6,000.00 |
| Forage legume costs (sdg) | 672.00 | 0.00 |
| **Total costs (sdg)** | **6,672.00** | **6,000.00** |
| Ewe returns | 5,250.00 | 5,250.00 |
| Lambs returns | 15,600.00 | 7,800.00 |
| **Total returns** | **20,850.00** | **13,050.00** |
| **Partial budget:** | | |
| Net benefits | 14178 | 7050 |
| Increase in return over control | 101% | |
| MRR (%) | 1060 | |

**4. Conclusions and Recommendations:** These activities clearly indicated that:

- Livestock technological innovations based on pipe conveyance irrigation systems are highly viable and economically sound and should be scaled-up in the area.
- Other technological packages in areas of rural dairy processing and sheep fattening need to be also disseminated for rural women at Lower Atbara region. Previous efforts, through phase I project, clearly showed that rural women capacities should be built and links with private sector be facilitated and strengthened.

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**Activity 4: Socioeconomics studies**

# Towards a Value Chains- Based Approach for Technology Transfer: Diagnostic analysis of Value Chains Components of Agricultural System(s) in Lower Atbara Area 2014-2015

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## Background

The area of lower Atbara falls within the arid zone which characterized by meager resources of rainfall and seasonal flow of Atbara River. The rainfall is highly erratic with annual mean less than 100 mm and chances of rain-fed farming are limited. Atbara River flows only during flood season from July to October and thereafter its flow is restricted by blocking of Khashim AlGirba dam. Irrigated agriculture is practiced during flood season through cultivation of flood receding in the low-lying riverine areas where floodwater is naturally overtopping the river banks, by direct pumping from the river for high contour areas, and by pumping from shallow wells, known as "*matara*". On drought years, flooding is hardly occurred or the flooded areas are limited or not existing. However, due to the new development of constructing the twin dams – Setiet and Upper Atbara dams on the upper eastern end of the river, a more stable and bigger flow of water is expected; this will make the river water available all the year around; will also improves the recharge of underground water and the water level.

The agricultural production that will be addressed here is irrigated farming by pumping irrigation water either, directly from the river, or from shallow wells, known as "matara". Rearing of animals is also a common practice; animals are mainly for household consumption but can also be a source of income. Generally, productivity is low but there are good potentials to improve productivity and profitability of both crops and animals. This has been shown by the results of the on-farm demonstrations of improved technologies conducted by this project with farmers / producers, which is highlighted below.

- ***Technically feasible and economically viable improved production technology:*** on farm demonstrations on wheat, faba beans, chick pea and common beans – improved varieties plus improved production package of: optimum planting date; seeding rate; N fertilizer (for wheat); frequent watering; and pest management. The improved technology for all crops resulted in significant yield improvement of between 70% - 94% over prevailing traditional practices. They also gave high monetary returns reflected in high marginal rates of returns (MRR) to investment

in the improved technology. (*see, reports of the On-Farm Demonstration and Yield Maximization Plots of Wheat and Winter Grain Legumes in Lower Atbara Area (reports for 2012 -2015).*

- ***Improved animal nutrition / feed supplementation:*** by using concentrates plus saltlick. The improved animal nutrition resulted in significant increase in milk production, and gave high monetary returns for both goats and cows. For example, in season 2014/2015, the improved nutrition regime resulted in 60% and 41% increase in milk production for goats and cows, respectively. The increase in cost of the improved nutrition regime is more than compensated for by the monetary returns to the productivity increase, and this is reflected in high rates of returns to investment in the improved nutrition regime, *(Range and livestock annual technical report, 2015).*

- ***Improved irrigation system:*** a pipe conveyance irrigation system has been introduced and demonstrated in farmers' field, and it proves to be highly viable and economically feasible. The advantages of the new system: saves water; better control of irrigation water and improves the efficiency of irrigation; reduces the time needed for irrigation and labor time required; and reduces the cost of irrigation, *(Water saving technologies (pipe conveyance system) report).*

It is evident that from the previous efforts through phase I of the project, and the efforts of phase II, that the improved technologies and innovations introduced and demonstrated in farmers fields provide very viable options for improvement of productivity, enhancing food security and alleviating poverty in Lower Atbara area. However, these could only be realized if these technologies and innovations are adopted by the community. Key pre-requisites for farmers' adoption of technologies and innovations, is a supportive and enabling policy and institutional environment, which promote, encourage and facilitates clients' access to these technologies. The supportive and enabling policy and institutional environment will the subject of this study.

## Objectives of the Study

The overall objective of this study is to review and analyze the institutional and policy environment of value chains of the farming systems in Lower Atbara area, and to assess how supportive is it to technology use by farmers / producers.

### Specific Objectives

1. Identifying and analyzing formal and informal institutions within the value chain of the farming systems in the area;
2. Mapping of the farming systems value chains components; functions undertaken along the chains, as well as the stakeholders / institutions undertaking these functions.
3. Analyzing segments of the chains and how the value chains partners cooperate and collaborate.

4. Draw recommendations on how to improve the linkages among value chain components, and effectiveness of the system

## Activities Conducted

i. Diagnostic appraisal: reviewed background information; visited project domain, observations, informal consultations, ..etc) to understand the context, issues along the VC - agricultural systems: farming / production systems; input and output markets; formal and informal institutions of service providers, research, extension / advisory services; farmers' groups.
ii. Identified the main value chain components or sub-systems of the farming system(s), functions undertaken along the chains and the key stakeholders and business partners
iii. Conducted situation analyses of the key stakeholders and institutions to analyze internal and external business environments, as well as the quality of linkages and coordination between business partners in the VC.

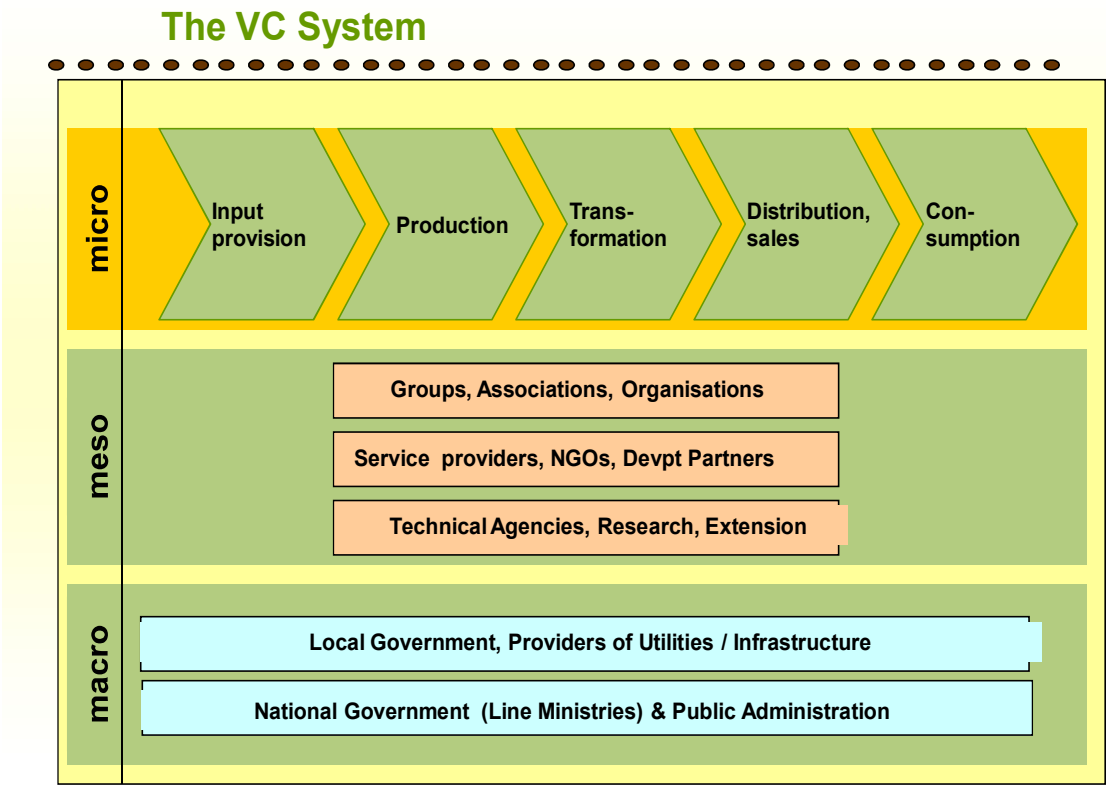
## Results and Discussion

### Value Chains: Conceptual Framework

*Definition of Value Chains:* The Value Chain (VC) is defined as the chain of activities, which transform raw materials into products that can be purchased by a final consumer.

The Value Chain (VC) is characterised by the sequence of production processes from the provision of inputs to primary production, to intermediary trade, to processing, to marketing and up to final consumption; and the quality of linkages and coordination between business partners in the VC.

The value chain system is composed of three sub-systems – micro, meso and macro (Figure below).




For the purpose of this study, the value chain components that will be addressed and analyzed are the formal and informal institutions in the three VC sub-systems of the farming systems in Lower Atbara area. The components of the VC system and the respective functions they undertake are:

***The Micro sub-system:*** these are called operators; will be confined to the producers or practitioners of agricultural and animal production and their institutions; the main functions they undertake are production practices including pre and post harvest functions.

***The meso sub-system:*** these are service providers, development partners, technical agencies, research and extension, and groups / associations and organizations. They do support the operators and their functions include:

- ✓ Avail and facilitate access to production inputs
- ✓ Advisory, extension and training services
- ✓ Research and development
- ✓ Credit and financial services
- ✓ Marketing information, market linkages
- ✓ Organizational development farmer groups

***The macro sub-system:*** the main stakeholders here are: local governments, providers of utilities / infrastructure, national government and public administration. They are called enablers and are expected to create an enabling environment for both operators and supporters. Functions undertaken by the enablers include:

- ✓ Macroeconomic policy (exchange rate, inflation, etc)
- ✓ Financial policy (taxes, tariffs, levies, etc)
- ✓ Legal framework (land tenure, standards, etc)
- ✓ Economic infrastructure (road network, markets, etc)
- ✓ Social infrastructure (education, health, etc)
- ✓ Administration (business establishment, enforcement, etc)

**Value chain Institutions**

Value chain stakeholders / institutions identified and surveyed and interviewed are:

- ➢ Producers: scheme owners and sharecroppers
- ➢ Service providers – credit institutions, input-output markets
- ➢ Research stations, Extension services
- ➢ Formal public institutions – ministry of agriculture / various departments
- ➢ Community – based organizations and farmers' groups

**Production Institutions**

A field survey was conducted by direct interviewing of 12 scheme owners and 45 farmers in 4 villages in the project domain; 58% are under matara irrigation system and 42% are under direct pumping from the river; 93% of farmers interviewed are male and 7% are females. At the farmers' community, institutions are based on resources (land, irrigation pump) ownership. In this respect, one can distinguish between two categories of institutions:

1. Scheme owner: this is the one who owns the irrigation pump; the pump owner can own the whole irrigated land (the scheme) or part of it.

2. Farmer or sharecropper: here the farmer can own the land or can be a sharecropper who does not own the land.

The main features of the production system(s) in Lower Atbara area are:

(i) *Production relations:* are based on resource participation and can be highlighted in the following:

- ➢ The responsibilities of the pump / scheme owner are: irrigation by operating the irrigation pump and availing water for farmers; land preparation by contracting for machinery services; and supply of purchased input particularly fertilizers and pesticides.

- The farmer is responsible for all management / cultural practices by providing his/her labor to undertake manual field management practices.

- The produce is shared equally between the two, after subtracting all the cost of purchased inputs, except spare parts and fuel.

(ii) *Decision making:* decisions related to production can be highlighted as:

- Crops to be cultivated, mostly agreed on between the scheme owner and farmers.

- Land preparation: mostly taken by the scheme owner since he is the one responsible for it.

- Purchased inputs: fertilizers and pesticides, mainly taken by the scheme owner.

- Irrigation: mainly decided on by the scheme owner since he is the one responsible for running the irrigation pump.

*(iii) Animal ownership:*

- Two thirds of respondents own animals, mainly for household's consumption but some may have commercial numbers specially sheep. Even for those household animals, they can also contribute to income and contribute to the needs in social occasions.

- Abu70 and sorghum are the main crops grown as fodder; there is also some who grow alfa Alfa for fodder. However, in the off-season farmers can resort to purchase of fodders whether it is abu70, alfa alfa and concentrates.

(iv) *Constraints:*

The main constraints reported by respondents are: availability and high cost of inputs – seeds; machinery services; fertilizers; pesticides; fuel and spare parts.

**State Ministry of Agriculture, Animal Resources and Forests**

Located at the state capital city ELdamer; it has five directorates: horticulture, crop protection, extension (agricultural and veterinary extension); seeds; and field and localities affairs. The head offices of Directorates are located in the state capital and there are branches in each of the seven localities. The lower Atbara area administratively belongs to Eldamer locality; it has two administrative units in Ela'tbarawi and Seiedon.

- The prime mandate of the Ministry of Agriculture is to support all farmers by provision of extension services through field demonstrations of improved production technology, and training through farmers' field schools which cover crop, animal production and forestry.

- The level of support provided to Lower Atrba area is by the various departments of the MOA is rated as poor and far below the actual need of clients and the area. This is attributed to the fact that the area is large and the weak capacity of the ministry to reach out to the rural communities of the area.

- SWOT analysis

    - ***Strengths:*** qualified human resources; availability of technical support provided by Hudeiba research station and Wadi Elnneil University, which are located in the state;

    - ***Weaknesses:*** inadequate transportation facilities to reach out for farmers and agro-pastoralists in rural areas; inadequate operational budgets to conduct extension and training activities; delays in provision of inputs and credit negatively affect timeliness of the calendar of agricultural operations and the technical support to be extended to farmers.

    - ***Opportunities:*** adequate political support and commitment at federal and state levels to agricultural development; this is reflected in the technology transfer Fund which supports availing of agricultural machinery; and improvement in credit and micro-finance support to small farmers; improvement in paved roads to rural areas which improve input / output trade and interaction between production and consumption centers; improvement in level of rain fall in the state; presence of externally funded projects and initiatives in climate change, water harvesting and rural development

    - ***Threats:*** federal and state level agricultural policies are not stable; increase in the rate of desertification threatens agricultural land; 88888888

**Credit institutions**

In an attempt to improve farmers' use of improved production technology, the government has undertaken good efforts to encourage credit institutions to increase its financing of small farmers. These efforts reflected in:

- Increasing the capital of the Agricultural Bank of Sudan, increasing our branches in production areas, and adopting flexible financing policies with small producers.

- Establishing a micro-finance unit within the central Bank of Sudan; with the intension to target small businesses including small farmers and agro-pastoralists.

- Encouraging State Governments to establish state level micro-finance units and agriculture development funds targeting small producers.

The main credit institutions operating in the River Nile State are: the Agricultural Bank of Sudan, the Farmer's Commercial Bank, and the River Nile Organization for micro-finance.

**The Agricultural Bank of Sudan (ABS)**

The Agricultural Bank of Sudan (ABS) is the main public credit institution mandated with providing short and medium term credit to farmers in all production systems. The ABS has three types of credit systems:

i. Financing individual farmers who have bank accounts with the bank;
ii. Financing individual farmers on their own collateral whether it is the land or a personal cheque;
iii. Financing group of farmers against group collateral.

**Farmer's Commercial Bank**

The Farmer's Bank credit policy is similar to that of the ABS. The main limitation as far as Lower Atbara area is that none of these credit institutions has branch(s) in the area. Credit seekers

**River Nile Organization for Micro-finance**

A public micro finance system which provides credit to individual farmers against their own collateral, or to a group of farmers against the group's collateral. The source of finance is from speculations with the central bank, other commercial banks and social security funds.

**Credit institutions: SWOT analysis**

- **Strengths:** generally, existence of qualified staff; improvement in the level of finance allocated to agriculture and small producers; improved engagement with key stakeholders such as input providers and producers' groups.

- **Weaknesses:** services are confined to cities and big towns where branches are found i.e. limited expansion of the service into rural areas where actual demand is there; bureaucracy and inadequate work aids and modern technology specially in branches;

- **Opportunities:** political commitment at federal and state levels towards support of small producers; development of a national policy towards support and development of micro-finance; expansion in agricultural investments and increasing demand for credit services; rise of the notion of establishment of grassroots and producers' groups which provide collateral to individual clients.

- **Threats:** the free market policy and higher rates of inflation; low clients' awareness and culture towards credit and micro-finance; high risk of agricultural production; low repayment and default by clients; taxes and levies on producers by state and local government.

**Contractual arrangement**

Following the recent move and improvement in providing credit to small producers, and in view of the fact that improving productivity necessitate clients' use of improved production technology,

- The business deals between newly established credit and micro-finance institutions from one side and the central bank and commercial banks on the other side, where the latter finance the former credit *****
- The contractual agreements between credit institutions and other service providers (seed companies, machinery service providers, fertilizer dealers, ..etc) who provide their respective inputs / services to the final users through the credit institutions
- Announcement of the crop floor price by the government before planting, and the commitment to procure the produce, is a form of agreement between the government and producers.
- The credit deal between the credit institution and producers and their groups, in which the credit institution provides credit to the clients, under agreed upon terms.

**Development projects**

Compared to other areas along the main Nile, Lower Atbara area has not received much public support with respect to infrastructure and basic services. However, in recent years there have been few externally funded community and rural development projects operating in the area. Of these, is the Butana Integrated Rural Development Project which has been working since 2009.

The main objectives of the project are: sustainable improvement of livelihoods and drought resilient communities; ensuring communities access to land and water resources; empowering of women and men and improve their negotiation capacity in marketing of their crops and animals; and improve the capacity of community –based organizations and their participation in community development.

The implementation approach of the Butana project featured: participation of grass root communities; bottom up approach in planning and implementation which ensures realization of community needs and engagement; service provision, capacity building of local communities and facilitate partnerships with service providers through agreements. The project uses a revolving fund scheme to fund its activities which are rotated to cover a large number of clients and communities.

The Butana Project is a good model for development projects that can be used to facilitate scaling out of improved production technology promoted by the ARC/ICARDA/IFAD project. The approach and the community based structures build would catalyze building strong and well organized demand which secures and ensures effective engagement in community development efforts.

**Community-Based Organizations**

One of the main factors contributing to the efficiency and effectiveness of technology transfer efforts is organization of beneficiaries (demand); a well organized and well engaged demand, is more likely to contribute to successful technology transfer efforts.

The role of civil society and community base organization is very central to the success of project working towards improving livelihoods of rural communities. They can help mobilize community and ensure their engagement in planning and implementation of activities. In the last decade, policies and legal frameworks have been developed by the government to guide formulation and operation of beneficiaries groups which take different forms – development committees, agricultural / animal production societies / groups, women development groups, ..etc. Examples of groups exist in the area are: Azza Society for Agricultural and Animal production; Alabar Voluntary Society for Development; Elnahda Society for animal production. These are village based group of farmers; each has an elected president and an executive office. The key objective of the society is to improve productivity, production and farm income through facilitating members' access to improved production technology and improving members bargaining power. The group provides collateral for its members, and deals with credit institutions and service providers to get the necessary credit or inputs; mobilize members and organize promotion and training activities with extension and other technical organs; and facilitate collective marketing or engage with crop buyers to obtain good prices.

## Conclusions

The agricultural production in Lower Atbara area is characterized by good soils and adequate water for irrigation which will improve after completion of the Atbara and Setait dams. The area is characterized by production of many crops ranging from cool season food legumes, vegetables and fodders. Generally, productivity is low but there are good potentials to improve productivity and profitability of both crops and animals. This has been shown by the results of the on-farm demonstrations of improved technologies conducted by this project with farmers / producers in the area. Also an improved pipe conveyance irrigation system has been tested and demonstrated with farmers in the area; it has proven its superiority over traditional systems with respect technical and economical efficiency.

The area has not received the due attention from public institutions and the level of support is poor and far below the actual need of clients and the area. This is attributed to the fact that the area is large and the weak capacity of the MOA to reach out to the rural communities of the area. On the other hand, the institutional set up of formal and informal institutions and its interaction among themselves and their engagement with the community is weak. It is therefore, necessary for formal institutions, service providers and community based organizations, to reach out for rural communities and enhance their engagement with producers and other stakeholders within the value chains of the production systems in the area.

## Activities of Year 2

### 1. Pipe conveyance water saving technology:

The second phase of the project emphasized achievement of the expected out-scaling objectives. The project has achieved significant outputs and demonstrated scalable interventions based on research activities done in phase one and demonstrations and validation done in phase two. The goal now is to scale out these interventions to larger number of farmers in collaboration with development projects.

A road map was prepared, in May 2015, in which a number of activities were proposed to establish pipe conveyance irrigation schemes in 56 small holder's farmers that would be identified by IFAD development project "Butana Integrated Rural Development Project" (BIRDP) operating in Lower Atbara site.

The IFAD development project was supposed to mobilize the financial resources to provide micro-loans to install irrigation units, and make all arrangements for loan agreements. Under IFAD window of micro-credit, IFAD was supposed to provide 75% of the amount of credit and the balance (25%) is supposed to be covered by famers' communities in selected villages. The project team from the Agricultural Research Corporation (ARC) was entrusted with the design and install of the conveyance systems.

**Update on the road map (October 15, 2015)**

Despite the great efforts that made with the village communities in the Project site of Lower Atbara to promote the pipe conveyance (PC) technology of irrigation, but the farmers did not respond positively because the cost of the technology was rather high (more than SDG 9000 per feddan equivalent to U$ 3348 per hectare).

The Director of BIRDP and his team in Edamer (IFAD) stated that even in the targeted communities, where they intend to apply the PC system of irrigation to about 50 beneficiaries using the Community fund allocated by IFAD project through its microfinance window, farmers are reluctant to apply the technology. This arrangement was based on agreement that IFAD pays 75% of the PC cost and the farmer pays 25%, but the farmers demanded that IFAD has to cover the full cost. This results in that none of the farmers, who are supposed to be funded by IFAD, will install the PC this season.

In an effort to introduce private micro finance agencies in the project area, a team including Dr. Waleed, the irrigation specialist, and the Project National Coordinator, accompanied a team from the Sudanese Company for Rural Development, which provides different kinds of finance including microfinance, was fielded to Lower Atbara area in the first week of September 2015. We visited three villages in Lower Atbara for a period of three days and conducted group discussions with farmers with the objective to promote application of the PC technology through

credit provided by the Company. Nonetheless, farmers indicated that the PC is expensive, although they acknowledge the benefits of it and at the same time, we realized that the Company would not provide such amount of finance in newly introduced area to them, and they are interested to provide only finance for short- term period (6-10 months depending on crop cycle).

To move forward, ARC/ICARDA Project suggested to bring the Microfinance Company and IFAD development Project together to sign a Memorandum of Understanding to facilitate cooperation between them in financing scaling up of agricultural technologies especially the PC irrigation system in the Project site in Lower Atbara. Under this agreement, the amount of 75% of the loan which would be provided by IFAD development project through its window of micro finance, whereas the 25% would be covered by farmers through credit provided by the micro finance company.

Following that, a process of consultation was made with farmers in the Project site and about 30 farmers in six villages were identified as being interested to install the pipe conveyance irrigation system.

In the Last week of February 2016, a team of irrigation technicians was fielded to Lower Atbara site to make the necessary measurements of the irrigation networks and estimate the cost of the system for each of the selected farmers. The cost estimates were made available to the selected farmers, IFAD development project and the Micro finance Company to make the decision and arrangement with regard to provision of the credit.

2. **Multiplication and production of improved seeds:**

Adequate improved seeds of main crops grown in the area (wheat, faba beans, common beans and chickpea) are not available in the market. The objective of this activity is to enhance production of improved seeds at farmers' level.

*A detailed report of this activity is forthcoming.*

3. **Socioeconomics activities**

a. Documentation of the performance of the already established six farms operating with pipe conveyance water saving technology
b. Socioeconomic survey of multiplication and production of improved seeds.

***As of March 2016, these activities have not yet been carried out.***

# YEMEN FINAL TECHNICAL REPORT

**Integrated Agricultural Production Systems for the Poor and Vulnerable in dryland Areas, Yemen**

Technical Report 2014-2015

Dr. Abdulla Sailan

Introduction:

Plan of work of 2014-2015 was approved in the Regional meeting for the Nile Valley and Red Sea Regional Program that was held in Cairo April 2014 to launch the activities of the new phase of IFAD project that came under the title of “Integrated Agricultural Production System for the Poor and Vulnerable in the dryland Areas”. Duration of the project was decided to start from March 2014 to March 2015.

Main objective of the project Is to transfer success technologies from the last phase into farmers and to establish a concept of “Research to Business’ where a model for each technology has to be established to insure technology outputs reach markets and farmers continuously adopt the technology and benefit from the technology. Overall aim of the concept is insure increasing farmer’s income and improve his household situation.

According to the above, program in Yemen has been decided to be restricted this year to produce a Research to Business model on the technology of improving cheep’s production in three selected villages, Telhamah, Bani-Saba’a and Al-Kubbah. There was a reason for choosing the three villages where Telhamah is the village where the technology was tried in the first phase for three years and farmers are aware of the technology and its impact, Bani-Saba village is considered as extension to Telhamah and livestock raising is higher relatively and agriculture is mostly under rainfed condition and agriculture in Al-Kubbah village is under rainfed and during the period of collection data about the villages it was found that farmers at Al-Kubbah village used to be livestock raiser but know very few farmers have small number of different livestock and use them only for household needs. That is because of lack of sources of fodders for animal feeding,

Plan of work of Yemen was comprise the following activities:

-Improving of sheep production through introducing improved male to poor farmers communities

- Introducing of feeding diet type to improve level of nutrition of poor farmer livestock

- Introducing newly released wheat variety, Bohoth3 with the recommended package

--Introducing newly released wheat variety, Bohoth37, with the recommended package

- Introducing 4 wheat varieties resistant to stem rust disease

- Introducing newly released lentil variety, Dhamar2 with the recommended package

- Considering establishment of marketing process of wheat and lentil crops in the location

Project in Yemen had been informed on November 2014 that Plan of work has been changed and only the livestock activities (mating with improved male of sheep and improving feeding) are still valid with preparation of model of Research to Business approach. Although, it was late warning the project concentrated on conducting the activities.

Project activities were conducted on May 2015 as preparation phase where some activities were conducted such as contracting with the Central Highland Agricultural Research Station to raise 12 improved mal sheep and multiplication of newly released wheat varieties and lentil variety to be used on winter season, December 2014 - January 2015.

Socio-economic study was conducted on June 2014. The activity aimed to evaluate the impact of improved male of sheep used in mating with female of farmers and the feeding recipe that has been started last year on improve sheep production and pricing and evaluate the level of this intervention in formulating model of Research to Business approach.

This report will concentrate on three main parts as follow:

1- Socio-Economic study
2- Impact of mating of improved male sheep and feeding on improve sheep production
3- Approach of Research to Business concept through sheep production

**Socio-Economic study on the impact of introducing improved male of sheep on sheep production at Telhamah village, 2014-2015.**

Background:

Livestock production is one of the important agricultural activities in the villages of Yemen. Farmers are relaying on livestock as one of the main source of income. Through the past time, agricultural activities concentrated on the plant side more on livestock relatively. That may led to deterioration of livestock production and sources of feeding such as range lands and forage. Farmers, at this point have kept struggling to raise their livestock with their own inherited technologies or indigenous knowledge. As a results of that, most of the preferable characters possessed in livestock have been lost through wrong approaches to livestock raising methods such as cross breeding and inbreeding through longer time.

It has been found that livestock characters such as twin production, general adaptation to local environment, tolerance to diseases, sheep health and overall production have been deteriorated. In addition, as a result of climate change mainly amount of received rainfall and neglecting of manpower rehabilitation of rangelands that have affected in reducing the source of livestock feeding. The only action farmers have taken is reducing the number of raised livestock in his house. All of that have affected the production and pricing of livestock which have a great impact on standard of family level.

During phase I of the project, attempt to improve sheep production was achieved through introducing an improved male of sheep and feeding recipe to farmers community at Telhama village.

During two years data were taken in improving the weight of born sheep, weight after 60 days of birth and twins production. It was found that weight of sheep at birth, weight of sheep after 60 days of birth was higher than those using farmer male in mating. During the phase II of the project it was agreed to use the same approach in the same village and other two villages.

In order to insure the technology intervention, improved male of sheep and feeding recipe, on production of sheep, it was agreed to conduct socio-economic study and ex ante survey to insure these technologies would be applicable to create a model of implementing of Research to Business concept.

Objective:

1- To identify the social and economic impact on livelihood
2- To determine the market price and the income of introducing improved male of sheep

Material and methods:

Questionnaire was prepared to collect data on most important issues such as social status in the village, impact of improved male on production and number of females included in mating with farmer and with neighboring farmers and most important characters of sheep with sheep produced from improved male and farmer male and prices.

Size of the sample reached 32 farmers. Sample was divided into groups:

1- Farmers that improved male were given to them
2- Farmers that used improved male in mating their female sheep
3- Neighboring farmers were not involve in mating but were following up the processes
4- Farmers involved in marketing and price collection

Percentage of farmers involved in mating with improved sheep male in the sample represented 67% while from non-participated farmer was 33%.

Results and discussion:

Social status:

Age of the farmers in Telhamah society was ranged between 72 and 20 years old. Highest old in males was 72 years and 58 years with the female. Percentage of male in the village was 77.8% and percentage of female was 22%. The highest percentage of population (41%) was found in the group of 41-50 years old (Table 1).

Table (1): Farmers age group and sex

| Age Group | Number | Percentage | Sex | |
|---|---|---|---|---|
| | | | Male | Female |
| 20 – 40 Years | 10 | 31 | 10 | 0 |
| 41-50 Years | 13 | 41 | 9 | 4 |
| 51-72 Years | 9 | 28 | 6 | 3 |
| Total | 32 | 100 | 23 | 7 |

Education level:

Surveyed sample involved almost all the education level available in the governorate: illiterate, read and write, middle education and higher education (Table 2). It has been found that illiterate represent 25%, read and write was 31%, went to schools (primary, secondary and high) 38% and college 6%. Farmers that used improved sheep for mating shared between all the education level and the highest percentage 6% were with the read and write.

Table (2): Education level and correlation to mating

| Group | Number | % | Farmers used Improved sheep for Mating | Seirman Correlation Coefficient |
|---|---|---|---|---|
| Illiterate | 8 | 25 | 5 | |
| Read and Write | 10 | 31 | 6 | |
| Primary School | 4 | 13 | 2 | 0.97 |
| Middle School | 5 | 16 | 4 | |
| High School | 3 | 9 | 2 | |
| College | 2 | 6 | 2 | |
| Total | 32 | 100 | 21 | |

Land ownership:

Results in table (3) showed that surveyed farmers that owned between 0 and 5 hectares represented 66%, owned 5.1 – 10 hectares was 12% and owned more than 10 hectares was 22%. It should be mentioned that where farmers owned smaller land used more of improved male for mating which means they are so keen to improve their household condition while owners of larger land have different sources of earning.

Table (3): Land ownership and correlation coefficient

| Land Owner | Number | % | Farmers used Improved sheep for Mating | Seirman Correlation Coefficient |
|---|---|---|---|---|
| 0-5 Hectares | 21 | 66 | 17 | 0.509 |
| 5.1-10 Hectares | 4 | 12 | 3 | |
| More than 10 Hectares | 7 | 22 | 1 | |
| | 32 | 100 | 21 | |

Number of owned Sheep:

Number of owned sheep per farmers has shown that farmer whom raising few number of sheep involved more in mating with introduced improved male comparing to the farmer that raise high number of sheep. That may explain the need of poor farmers to the new technologies in order to improve his production more than well off farmer (Table 4).

Table (4): Number of sheep, percentage of mating and correlation coefficient

| Land Owner | Number | % | Farmers used Improved sheep for Mating | Seirman Correlation Coefficient |
|---|---|---|---|---|
| 0-51 Heads | 11 | 34 | 8 | 0.604 |
| 16-30 Heads | 5 | 16 | 3 | |
| 31-45 Heads | 7 | 22 | 5 | |
| 46-60 Heads | 6 | 19 | 3 | |
| 61Heads and More | 3 | 9 | 2 | |
| Total | 32 | 100 | 21 | |

Characters of the produced sheep from the mating with improved male:

It was important to reveal the impact of mating with improved male of sheep on improving some preferred characters by farmers and collect data on farmer opinion on those characters. Data show that some important characters were appear in the offspring's of improved male such as weight of born lamb, less lethality and ability to consume any type of fodder. Reducing of percentage of lethality is an important character which has direct impact on production. Also, that could be related to the tolerance of new born sheep to the environment. Since source of fodder is limited ability to consume any type of feeding is considered to be as good character.

Table (5): Rating of some characters of sheep produced from mating with improved sheep and farmer's sheep

| No. | Factor/Character | Comparison | | | |
|---|---|---|---|---|---|
| | | Improved Better | Local Better | No. Difference | No Idea |
| 1 | Size at birth and Growth Rate | 100 | 0 | 0 | 0 |
| 2 | Tolerant to Environment | 23 | 0 | 11 | 63 |
| 3 | Hanger Tolerance | 0 | 0 | 22 | 78 |
| 4 | Eating All Type of fodder | 100 | 0 | 0 | 0 |
| 5 | Tolerant to Diseases | 41 | 0 | 35 | 24 |
| 6 | Death Rate | 88 | 0 | 12 | 0 |
| 7 | Fertility Rate | 44 | 0 | 0 | 56 |
| 8 | Twins Production | 56 | 11 | 33 | - |
| 9 | Test | 33 | 0 | 0 | 67 |
| 10 | Market demand | 100 | 0 | 0 | 0 |
| 11 | Price | 100 | 0 | 0 | 0 |
| 12 | Shape | 100 | 0 | 0 | 0 |

Price and marketing:

Analyzed data show that price of new born of mating with improved sheep was higher at age of six month comparing to born sheep from farmers male mating. Average price of six month sheep of improved male was 22111 Yemeni Riyal while sheep of farmer sheep average was 18000.19 YR. New born of sheep from farmer male cannot be sold at age of 6 month because size and weight is low and farmer keep feeding the sheep till to reach age of 8 months. Cost of feeding of extra 2 months period was calculated and average was found to be 7200 YR. Farmer could save 11,311 YR from selling small sheep produced from improved male as price of the seep and price of saved fodder.

Surveyed farmers revealed that price of sheep produced from improved male exceeded sheep produced from famer male with 68% and that of second generation exceeded with 7%. Farmers revealed that main obstacle of increasing livestock production is source of fodder since only 65% of fodder can be found in the village and rest are bought from outside.

Table (6): Price of sheep, age and percentage of increase of production from mating with improved sheep and farmer sheep

| Comparison | Birth from Improved Male | Birth from Farmer Male | Birth from first Generation of Improved Male |
|---|---|---|---|
| Average Selling Price | 23111 | 18000 | 19250 |
| Sheep Age at Selling Month/Sheep | 6 | 8 | 8 |
| Average Selling Price + Forage saving | 30311 | 18000 | 19250 |
| Percentage of Increase | 68% | 0% | 7% |

Economic activities of farmer household:

Percentage of farmers in the village working in pure agricultural work reached 72% and 28% involved in trading and traders of crops and livestock in the neighboring markets. Farmers whom are depending mainly on livestock raisings represented 34% and out of that 46% are female.

Farmer priority of raising livestock:

Farmers are raising livestock and working on improving their production in order to meet their priority in their household demands. Their priority as they ranked them as follow:

1- Improve their standard of living
2- Increase the household income
3- Food demand
4- Improve health and education of the family member

Conclusion:

1- Farmer community still looking at the livestock as a major part in their agriculture and important for improving their standard of living
2- All farmers in the village raise livestock and number of sheep per family depend on status of income
3- Poorer farmers are trying to deal with new technologies in improving livestock production more than well off farmers relatively.
4- Using of Improved male of sheep in mating has improved some characters of sheep which has a great impact on price and marketing.

**Impact of mating of improved male sheep and feeding on improve sheep production**

Materials and methods:

Nine pure improved males of sheep were introduced into the farmer community in the three villages. Sheep raiser farmers were selected in the three villages to adopt the improved sheep male and nutrition treatment. Procedures of mating process and taking data was taken by farmer and project team responsible, researcher and extension agents. Training women on procedures of following up taking data and selection pure sheep male from their flock was undertaken. Implementation of the activity started on December 2014 and January 2015.

Nine male sheep were distribution to 9 farmers, 3 in each village. Selected farmers were as follow:

Bani-Saba:

1- Mohamed Ahmed Al-Assoudi
2- Mohamed Mohamed al-Masabi
3- Ahmed Nasserr Al-Asadi

Telhamah:

1- Saleh Ahmed Al-Ashwal
2- Badr Mohamed Yehya Al-Kohm
3- Mohamed Ali Mohamed Kuhmi

Al-Kubbah:

1- Esmaeil Kutaish
2- Ali Abdulla Ahmed
3- Saleh Ali Shaiekh

Selected sheep female for mating with introduced improved sheep were tagged and other female that will be mate with farmer sheep. Activity was followed up in order to identify the mated process and to introduce the feeding to the selected sheep. Suggested diet was consist of 45% crushed wheat, 45% crushed barley, 2% urea and 8% salt. Weight of sheep was taken before and after mating in each village.

Feeding process: Feeding treatment was introduced to farmers in Bani-Saba'a village two weeks before mating and two weeks after mating aiming to enhance metabolism and fertility. Second

dosage will be introduced after delivery in order to increase milk production that will enhance growth and weight. Amount of feeding was 250g per head per day for 30 days at the two dosages.

Farmers, researchers, livestock specialist, extension agents and local extension, socio-economist and cooperative participated in implementing the activity.

Frequent meetings were held to maintain the interaction process of the activity team and farmers concerning all aspects of activity implementations.

Results:

Data on birth weight, type of birth, and other data will be taken after middle of June 2015. As a result of that analysis of data and writing final technical report will be undertaken after June 2015.

**Research to Business (R2B) in sheep production in Yemen**

Concept of Research to Business is a new concept research in Yemen and the year of 3014 is the first time that concept is applied in agricultural Research and Extension Authority (AREA). In fact Research to Business concept is what is messing end part in the research cycle mainly after the technology is tested at farmer level and approved its success. Research to Business concept is the approach that help farmer to get the way to benefit and research to continue evaluating the impact of the technology at the farmer level, market level and even at the national level. Since it is the first time to be applied, success may not be achieved from the first year and misunderstanding and finding the way of application may take time, however many lessons during this period of implementation have been learned.

During January 2015 national coordinator was invited to Cairo for attending several meeting with the regional coordinator of ICARDA/Cairo office, director of Socio-economic and policies program at ICARDA and project staff at Egypt. Purpose of the visit was to streamlining the ideas of creating model for Research to Business approach. Several meetings were held with main stakeholders at Egypt resulted in elaborating ways of creating the model in Yemen. After coming back from Cairo several meetings were held to elaborate a model for applying and maintaining the concept of Research to Business with different stakeholders concerning production of sheep by farmers in the three selected villages, Bani-Saba, Telhamah and Al-Qubah, of project location. Meetings were held with the different stakeholders as follow:

Saturday 17/1/2015, meeting was held in the Central Research Station with the concerned research staff mainly livestock specialist. Briefing on the concept was introduced by the project national coordinator. The idea of the meeting was how to create a model of R2B for sheep production in the three villages and making these three villages as a platform for livestock production improvement.

Elaborating the idea was maintained. Many suggestions were discussed in the meeting such as contacting dealers, restaurant and fattening agencies. Main suggestion was to start contact with the Livestock Dealers that moving from place to place to purchase sheep and to introduce the idea of establishing contact line between these dealers and the farmers in the village. Second step is to

have a meeting with dealers and farmers to explore the teams to each other and discuss the issues of establishing way of contact and coordination different steps such as production time, purchase mechanism, purchase price and others.

At the same time, it was agreed to execute meetings between team of the activity and farmers in each village to introduce Livestock Dealers to sheep raisers to the three farmer participants in the activity and other sheep raiser in the village. Maine issue in this meeting is to gather more farmers to follow up the activity steps and evaluate the results and to be part of the project in the next season in the innovation platform.

Sunday 18/1/2015, meeting was held with the Director General of the Agriculture and Irrigation Office, Dhamar and the specialist on livestock in the extension department. Meeting opened by the DG and first speech was for the NVRSRP National Coordinator. National Coordinator introduced the elaborated vision of the Research to Business (R2B) Model and how both partners can approach to maintain the Model. In addition, suggested some steps to move to establish the model and activities that should be conducted to elaborate the innovation platform in the locations. It has been agreed to continue meetings and brain storming on different agencies to establish the R2B Model.

Monday 26/1/2015, meeting was held with livestock Dealers. Purpose of meeting was to introduce the project aim to the livestock Dealers whom are taking care of buying the animals and distributing them into many sides.

Animal Dealers are collecting animals from different village in Dhamar governorate. Animal Dealers are selling their animals to different sides mainly Boucher, restaurants and during religious events to public. Animal Dealers have a known place in Dhamar (Merba'a) where livestock are brought into the market for selling and buying. It should be mentioned that Livestock Dealers are bringing livestock from different cities in Yemen mainly Hodaidah.

Livestock Dealers appreciated the idea of buying livestock from farmers according to the characters that allow them to sell them easily. Elaborating the processes needs more meetings mainly with farmers.

Thursday 29/1/2015, meeting was held with farmers at Bani Saba'a village. Purpose of meeting was to discuss the issue of R2B model in the livestock. Meeting started with introduction to the purpose of the activity of introducing improved lamb and feeding treatments to the village and how production can be linked to market to enhance two things; first to insure and facilitate marketing the sheep products through creating channels of marketing, second to encourage farmers to improve their livestock production. During the meeting farmers described the importance of livestock in their live in a way turning attention to improve livestock is very significant. Livestock is considered as a savings for the farmer, when runs out of the cash he turned to his livestock and sell one or two animals to meet his requirements. During shortage or price increasing of fuel mainly diesel, livestock solve his problem through selling one or two animals to meet fuel cost. Livestock is sold either in the village or taken to nearest market (Mabar city) for selling. There is no identified marketing process for livestock. Farmers are realizing the importance of livestock in their livelihood needs, but they have not done any serious action to improve the livestock production. One of the most

important problems that farmers face is limited sources of feeding. Range are limited and sufficient only during season of rainfall. Residual of plant straw is not enough to meet the demand of producing healthy and high number of animals. Obtaining different sources of animal nutrition will be a very essential.

Farmers respond was very encouraging to the issue of R2B. It was noticeable during the meeting that farmers have not picked up the whole story about the R2B, however they have at least understands that they have to pay more attention to livestock since it very important to their live and establishing a mechanism of marketing of livestock is appreciated.

Tuesday 5/2/2015, meeting was held with farmers at Telhamah village. Farmers in this village are aware of the technology since they participated in the project Phase I. During discussion with farmer they describe the importance of livestock in their live. Also, they appreciated introducing improved male of sheep to the village and the feeding process that been applied and the impact of the two technologies on producing healthy sheep that sold with higher price comparing to sheep mated with their male of sheep. Lack of source of fodder in the village still represents the main problem to improve their livestock production mainly to small farmer that cannot afford buying extra fodder. Concerning the model of link their product to the market will be a good idea and they assigned the local extension to coordinate with livestock dealers and or fattening farmer to buy their sheep at required time. Only thing they were hesitating in the agreement is during this time their production may not enough to meet the demand of those sides.

Three meetings were held with restaurant holders in Dhamar City. Restaurants holders revealed no objection of buying sheep production from farmers in the villages. Restaurant holders explain that they introduced sheep and goats from Hodaidah city and leave the livestock in assigned place near their restaurants. So buying sheep from Dhamar may reduce cost of bring animals from different cities.

Meetings were held with Fattening Farm: with continue investigation and searching we have found a Fattening Farm at Dhamar city. We have contacted the owners of the fattening farm and discussed the issue of the possibility of creating a communication line between the fattening farm and farmers that will produce sheep in the three villages. Owners of the fattening farm showed a very encouraging level of accepting the idea and reveled that they will buy sheep from farmers whenever it is ready.

**Conclusion of conducted meetings:**

- Farmers are so keen to deal with any side that will help in organizing buying their sheep production but they need to insure that their production will meet the specification of the buyers mainly if they cannot offer good feeding to their animals.
- It seems that fattening farm owners showed serious willing to communicate with farmers in the villages, buying all the sheep production, participating in events during activities conduct in the villages such as meetings, field days and even participate in training if we need. Owners of fattening farm are veterinarians and have worked in sheep production abroad and now they are settling in Dhamar.

- Still mechanism of implementing R2B needs more work in establishing applicable steps and solid foundation to maintain sustainable model for sheep production and marketing. Poor farmers may not be able to reach a good level of production and well off farmers may not be able to full fill the requirements of buyer agencies at least during the nearer time. However maintain the channel and reasonable price of sheep through the model may encourage farmer to pay more attention to sheep production.
- During meeting contracting issue was introduced to famers and other stakeholders. It seems they were escaping doing contract with the two sides. As traditional in Yemen signing contract is only made for bigger cases. However all parties are agreeing in selling and buying sheep at the required characters.

**General Remarks:**

Political crises and internal semi-war that started on July-August 2014 has made some difficulty to move and continue the work smoothly. Security, lack of fuel and even farmers were not really so keen to discuss the matter of sheep production and marketing and always declare things may be work better after the crises is ended. March 2015, external and internal war started that has made it even worst.

**Progress report on activities conducted on the April – September, 2015.**

In order to complete the work on activities of improved male of sheep and feeding, some activities were undertaken during the period of April to September 2015. Data collection and analysis is important in these activities to finalize the evaluation and draw conclusion on the impact of these technologies on improving sheep production at the village level. In this regards many visits to the location was conducted for distribution of feeding to the farmers in the three villages and to collect data on new born lambs (Table 1).

Table (1): Location, number of visits, dates and purpose of visits during the period of April-August 2015

| Location | Number of Visits | Date | Purpose |
|---|---|---|---|
| Bani Sab'a Village | 1 | 16/6/2015 | Feeding Distribution |
| Al-Qubah Village | 1 | 21/6/2015 | Feeding Distribution |
| Telahamah Village | 1 | 23/6/2015 | Feeding Distribution |
| Bani Sab'a, Al-Qubah, Telhamah Villages | 3 | 24, 27, 28/6/2015 | Following up Delivering |
| Bani Sab'a, Al-Qubah, Telhamah Villages | 2 | 5, 7 /7/2015 | Weighing of delivered lambs |
| Bani Sab'a, Al-Qubah, Telhamah Villages | 3 | 5,6,9/8/2015 | Weighing of delivered Lambs |

Last visits will be conducted during the end of September 2015 for taking data on weight of lambs at weaning time.

After taking all data it will be analyzed and technical report will be prepared.

Table (2): Expected number of visits, dates and purpose of visits during the month of September 2015.

| Location | Number of Visits | Date | Purpose |
|---|---|---|---|
| Bani Sab'a, Al-Qubah, Telhamah Villages | 3 | 13, 14, 15/9/2015 | Weighing of new lambs |
| Bani Sab'a, Al-Qubah, Telhamah Villages | 3 | 27, 28, 29/9/2015 | |

Research to Business concept:

Meetings were held on 27, 28 and 29/6/2015 to discuss the overall understanding of research to business concept and how we are conducting that on livestock (Sheep). Participants to this meeting were almost all the project team, concerned researcher in the Central Highlands Research Station and extension agents in the Ministry of Agriculture and Irrigation Office/Dhamar governorate including the DG. Purpose of the meeting was to clarify the concept to other partners and explain the experience on conducting this activity with sheep. That was because of so many questions and enquires about the concept were raised and we thought it is necessary to held a meeting. All attendance appreciated the concept and even discussion about testing implementing the concept on other commodities was taken place.

Marginal meeting was held with the owners of the fattening farm concerning buying lambs from farmers and the suggested mechanism by farmers to assign the local extension to be the one who could coordinate between farmers and the fattening farm. It should be mentioned that fattening farm prefers lambs just after or during weaning.

In general model of concept research to business has, somehow crystallized as following:

1- Farmers are accepting the technology of using improved lamb and feeding recipe to improve their sheep production. Farmers agreed to sell their sheep (lambs) to the fattening farm and livestock whole seller with the coordination with the local extension to be as a focal point.
2- Focal point will contact and coordinate with buyers when there are enough of lambs for selling.
3- Buyers (Fattening farm and livestock whole seller) will coordinate with the focal point in the village to determine the selling seasons or so.

Note: In fact most of the activities mentioned above was done or will be done with no budget support. AREA is promising to provide some support but with the situation in Yemen and the very low current budget available may not be any support. Exercise is accepted from all partners and if there was some time and some fund exercise success would have been proven.

Technical Report, 2015-2016

**Progress report on dissemination of improved male of sheep to a two new villages, Mankadah and Al-Hejrah, 2016.**

Introducing improved male of sheep to Telhama village in the phase I of the project to improve sheep production through restoring the preferred features of sheep that have been lost through inbreeding or crossing with different strain has proven improving of production of strains of sheep that crossed with the improved male. Main features were higher weight of new born of sheep, higher weight of at weaning, production of twines and wide adaptability to Central Highlands environment. In this regards, the idea was adopted during project phase II targeting in 2014-2015 tow villages, Bani-Saba and Al-Qubah, in addition to Telhamah village to become three villages. As the evaluation of this technology was positive relatively in improve sheep production and farmer involved income, during 2015-2016 two villages, Mankadah and Hijrat-Mankadah, were added.

The activity was initiated on March 2016, started with searching for three cooperative locations that livestock is important and many farmers raising a respectable amount of sheep in their houses. Two locations were found in two villages, Mankadah and A-Hejrah. Activity was conducted in the first location, Mankadah, with the farmer name, Abdulwahab Abdullah Al-Aldarbi on 8/3/2016. Second location, Al-Hejrah village, activity was conducted with the farmer name Housain Saleh Al-Samein on 13/3/2016.

In the two locations, 30 heads of female sheep were selected for the activity. Estimated age of female sheep was taken through their teeth. All sheep were treated with Bendazol as antibiotic and weighing the sheep at the beginning of the trial. Average of weight of before mating was found to be 21.1 kg. Selected sheep were divided into two groups as follow:

- First group, with number of 15 mating with improved male
- Second group, with number of 15 mating with farmer male

Expected birth at the first location will be on 8/8/2016 and will extend up to end of August. Weaning expected to be on mid of October. In the second location, expected birth will be on mid of August till the end and weaning expected to be on mid of October. During this period many visits to the location were planned to collect data about the performance of the technology in the tow new villages.

Expected date for preparing technical report will be on end of October after taking data on weight of birth and at weaning.

**Training on preparation of concentrated feeding at project location**

Introduction:

Livestock is very important to farmers in Yemen. Traditionally farmers having livestock in their house is a most and no single farmer do not raise two or more type of livestock in his house. Main source of feeding is the stock of crops such as wheat, barley and sorghum. Mentioned source of feeding is not enough to improve the animal weight and with low nutrition value animals are subjected to different diseases. Herding animal is common in Yemen. However season of herding is limited depends on amount of rainfall that help in grow edible plants. Under the low rainfall situation range become a very limited source for feeding. This situation force farmers to sell their animals avoiding the risk in animal raising under the lack of feeding sources.

Obtaining different ways for improving livestock nutrition will help in improving production of livestock mainly in Central Highlands rejoin where nutrition program of livestock is weak and not really meet the requirement of livestock to grow in a good health. This approach will help in improve farmers income which in turn will improve farmer standard of living. Training farmers on methods of improving livestock nutrition through preparing concentrated feeding will have a positive impact on increase productivity by supplying livestock with healthy nutrition mainly during period of lack of feed sources during dry seasons.

Main objective of the activity is to enhance farmers skills in preparing simple and efficient concentrate feeding that farmers can affords and help in improving their livestock nutrition.

Material and methods:

Training was conducted for 13 days in which 3 days were spend to buy the raw materials, 5 days for coordination with farmers in the villages and five days training sessions in five villages, Bani-Saba, Telhamah, Al-Qubah, Mankadah and Hijrat-Mankadah. Coordination with the local extension helps in gathering farmers to attend the training sessions and to train him to be source of information that farmers can turn to.

Training session start with description of the raw materials used, weighing each material in each proportion and mix them to prepare 10 kg of the concentrated feeding. Discussion on the importance cases to introduce the concentrated feeding was maintained in which pregnant female and sheep and goat fattening and increase milk production are of the important cases.

Concentrated feeding:

Two types of concentrated feeding where discussed and agreed upon. Criteria of selecting the component of the two concentrated feedings are the availability of these two types with farmers or in the local market and its cost is low that will not cost him more fund to buy. Table (1) and (2) show the different component of concentrated feed and percentage of each.

Table (1): First concentrated feeding recipe

| Raw Material | Percentage | Protein % | 5 Kg | 10 Kg | 100 Kg |
|---|---|---|---|---|---|
| Wheat Grains | 33% | 12% | 1.65 | 3.3 | 33 |
| Barley Grains | 30% | 11% | 1.50 | 3.00 | 30 |
| Nakalah | 30% | 15% | 1.50 | 3.00 | 30 |

| | | | | | |
|---|---|---|---|---|---|
| Urea | 2% | 2.9% | 0.10 | 0.20 | 2 |
| Sodium Chloride | 5% | - | 0.25 | 0.50 | 5 |
| Total | 100% | 17.56% | 5.00 | 10.00 | 100 |

Each 1 Kilogram contains 175.65 crude protein and 3000 Calories

Table (2): Second concentrated feeding recipe

| Raw Material | Percentage | Protein % | 5 Kg | 10 Kg | 100 Kg |
|---|---|---|---|---|---|
| Wheat Grains | %30 | 12 | 1.50 | 3.00 | 30 |
| Corn Grains | %20 | 8 | 1.00 | 2.00 | 20 |
| Barley Grains | %23 | 11 | 1.15 | 2.30 | 23 |
| Nakalah | %20 | 15 | 1.00 | 2.00 | 20 |
| Urea | %2 | 2.9 | 0.10 | 0.20 | 2 |
| Sodium Chloride | %5 | - | 0.25 | 0.50 | 5 |
| Total | - | %16.53 | 5.00 | 10.00 | 100 |

Each 1 Kilogram contains 16.53 crude protein and 3000 Calories

Results:

Farmer attendance in each village was out of expected. 105 farmers attended the training sessions from the five villages. Highest attendance was from Hijrat Mankadah with 32 attendance followed by Telhamah village with 22 attendance. The most important observation was the attendance of farmer women mainly from Hijrat Mankadah, Bani-Saba and Al-Qubah villages (Table 3). Farmer women showed a great interest and interaction through their asking and discussion. In fact women work in livestock raising represent more than 70%. High farmer attendance may show the importance of livestock to Yemeni farmers and the need to improve their production. A great appreciations to the trainers was found from farmers in all villages.

Table (3): Number of farmer participants to the training session in each village

| Province | Village | Number of Participant Farmers | | Total |
|---|---|---|---|---|
| | | Male | Female | |
| Jahran | Bani-Saba | 17 | 2 | 19 |
| | Al-Qubah | 13 | 1 | 14 |
| | Telhamah | 22 | - | 22 |
| Ans | Mankadah | 18 | - | 18 |
| | Hijrat Mankadah | 24 | 8 | 32 |
| Total | | 94 | 11 | 105 |

**Photos of attendance in the five villages:**

1- **Bani-Saba'a village**

## 2- Al-Qubah Village

## 3- Mankadah Village

4- Hijrate  Mankadah Village

**5- Telhamah Village**

**Improving marketing mechanism of wheat and legume crops at Central Highlands**

Marketing mechanism of wheat and legumes in the Central Highlands is not well identified that could encourage producer farmers of wheat and legumes to produce higher quantities of these crops and guaranty selling their products to a buyer.

Wheat and legumes are produce by farmers mainly to meet their household consumption in order to secure grain food to their family. Some farmers may produce more quantity than what the family needs they sell the extra amount either to farmer neighbor or to a market where small grain dealers could buy it.

Existed marketing mechanism in the Central Highlands can allow only small quantities of wheat and legumes to be traded but for higher quantity small grain dealers are not able to buy it. Since there is no other agency to by the higher product, farmers tend to plan in advance to grow wheat and legumes in small areas. This created a habit with farmers in which they, in most time, even do not apply good management to the crop such as adding optimum amount of fertilizers or bather to

control weeds and so forth. This situation created a general case in which standard of yield become so low, shortage of local production of wheat and legumes in the market and bills of introducing wheat from outside the country getting higher. In addition producing of new varieties of wheat and legumes only used by farmers consumption and rest of population consume introduced wheat and legumes.

Cash crops, such as potatoes, onion, cabbage.. etc. played a role in reducing the farmers attention to produce grains and pulses for market demand and help in farmers producing wheat and pulses in small areas to meet their household consumption and rest of the land grown with cash crop for market demand. Existed situation, no identified marketing channel for grains and pulses, and higher price of cash crops attempt farmers to grow wheat and pulses in restricted areas.

In order to encourage farmers to produce higher grains and pulses, provide local production to be consumed by population and to reduce the importing bills of these crops, improving marketing channels in the Central Highlands could play a good role in this case. For that purpose, several meetings where held with project team and relevant institutions such as extension, seed multiplication and local authorities to expose the reality of the situation and discuss the possible ways to improve the situation.

One of the encouraging issue, during discussion with farmers concerning this issue, farmers declared that availability of good quality of seeds and identified marketing channel to ensure good price of grains and pulses will encourage farmers to produce higher quantity for market purpose. Also, they declared that growing of cash crops have higher cost of production and higher standard of risk.

**Meeting findings**

First scenario:

Group of farmers trained in producing good quality of seeds for farmers could play a good role in supplying good quality of seeds either for neighboring farmers or for other farmers in the neighboring villages. This proses will encourage increasing crop yield as a result of using healthy, pure and plumed seeds. Farmer seed producers will fill the gap of Seed Multiplication Corporation in meeting the farmers demands.

Farmer seed producers need to explore themselves to farmers in the village and to neighboring villages. Relevant institutions, such as research, extension and local authority may help these group of farmers in expose them wider clans. That would encourage producing more seed and even grains for consumption. Once that established and farmers concerned gain more income they will grow all of their lands with wheat and pulses and may rent other farmers land for production.

Local small grains in the governorate will be invited to explain the situation to them and create a good coordination mechanism with them and grains producers for consumption to arrange time for buying extra grains production.

Once the production is over the capacity of local grain dealers, big grains importer will be invited to buy the extra production of grains. That will reduce the importing bills and will be reflected on the economic situation of the country.

Second scenario:

Encouraging private sector to create an agency or structure in the government that could deals with farmers and buy seeds and/grains from farmers. The suggested agency or structure could be created from the small grains dealers. Once that established, farmers will be encouraged to produce higher quantity of grains either by increasing areas of production and/or by applying good management to the crops.

A good contact with big grains imported could be established with this agency to establish a way of buying grains from this structure or agency. This, also, will help in moving the wheal of wheat production in the government and will give the wheat and legumes to compete with cash crops.

Third scenario:

Big importers of wheat and legumes will be contact to turn their attention to the local production and how they could help local wheat producers in producing higher quantities of these crops, only if big importers of wheat convened and start to establish a good contact with small grain dealers or with wheat producer farmers through the local authority.

General comment:

During one the meetings in the ministry of Agriculture and Irrigation, head quarter, this issue was raised during the discussion. Deputy Minister for Agricultural Services declared that big wheat importers are ready to buy the local production but if good quantity of grains are available in the market and even they prefer to buy local wheat production than importing. This was a new idea for us.

During writing this report is Ramadan and most of governmental employee are taken a holiday in this month good contact and moving may not be useful. After month of Ramadan, project team will conduct many contact even with the ministry to collect more ideas and crystalize line of good marketing mechanism.

Staff of Agricultural Research Authority and extension office in the government of Dhamar appreciated raising marketing issues by the NVRSRP's team.

**Impact assessment study of using improved male of sheep in improving sheep production, 2016**

## Introduction:

Adoption of a technology produced by agricultural research is one of the most important issue for counting the agricultural research donation in the development of the country generally. Adoption of a technology show the level of research understanding of farmer production problem and obtaining the wright solution for that problem.

Deterioration of livestock production in Yemen can be related to many factors. Out crossing in livestock, mainly from rejoin to rejoin, play an important role in losing the main features in local livestock that farmer prefers. Poor livestock nutrition is acting in lowering production of livestock in which low meet production, producing weak offspring and decreasing tolerance to common environment and livestock diseases.

In order to improve sheep production in Central Highlands in Yemen, improved male of sheep were introduced to three villages, Telhamah, Bani-Saba'a and Al-Qubah during phase II of the project. Improved male of sheep were used as a technology to improve sheep production through mating the improved sheep male with farmer female sheep. Improved male of sheep possessing the main features that farmers are preferred. Improved male were selected through different breeding steps and raised in the Central Highlands Research Station. Those male are used to restore the features of wide adaptation to the Central Highlands environment and farmer preferred features such as increase in weight of newly borne sheep, weight of lamb at weaning and production of twins.

Trials started on 2010 2011by introducing the improved male of sheep to one village, Telhamah. Following up all the steps of research were undertaken through 3 years. In 2014, two villages were added to Telahmah village and male of sheep were introduced to those villages. Data were collected from three villages during the period of 2014-2016. Almost all result averages showed improving of lamb weight at born, at weaning and in some cases twines production.

In this study, the impact assessment of introducing male sheep to the villages was assessed. Very promising results were found in improving production of sheep that reflected positively on rate of farmer adoptions and increase in farmers income generally.

## Material and methods:

Packages of Excel and SPSS were used in analyzing the data. Adoption rate, adoption degree and adoption density were used as indicator for analyzing the impact assessment. To study the development and form of adoption rate following formula was used:

$$Y_{t=\frac{K}{1+e^{-z-xt}}} \qquad (1)$$

K: Rate of highest adoption
Yt: Dependent rate of adoption accumulation at *t*
t: Independent factor, time
X&z: Constant that can be calculated using OLS.

Studying of factors affecting farmer decision on feeding recipe, following formula was used:

$$Log\left(\frac{p}{1-p}\right) = B_0 + B_{x_i} \qquad (2)$$

For identifying size of the sample, following formula used was:

$$n = \frac{pq}{\frac{pq}{N} + \frac{E^2}{(Z_{\propto/2})^2}} \qquad (3)$$

n: Sample size
p: Rate of dependent= 30%
q: Completed rate of P =70%
z: … rate. In this study =1.96
E: Error allowed. In this study=9.1%
N: Size of population

$$n = \frac{0.21}{\frac{0.21}{150} + \frac{(0.091)^2}{(1.69)^2}}$$

By applying the formula to identify size sample, results show that optimum size of sample was 84 in Telhamah, Bani=Saba'a and Al-Qobah villages. Distribution of sample was carried out according to number of farmers involved in ach village.

**Results and Discussion:**

1. **Study of some adoption indications:**

1.1. <u>Participants and non-participants farmer adoption study</u>

Results showed that all participant farmers adopted mating female sheep with improved male, 57% of non-participated farmers adopted mating female sheep with improved male. Degree of adoption of total sheep flock reached 44% (Table 1).

Table 1 Rate and degree of adoption of participation

| Type | Number | % | Rate of adoption | Degree of adoption | Density of adoption |
|---|---|---|---|---|---|
| Adoption | 35 | 74.4 | 74.4 | 44 | 32.7 |
| Participant Farmers | 19 | 40.5 | 100 | 27.6 | 27.6 |
| Non-participation and adopted | 16 | 34 | 57 | 16.6 | 9.5 |
| Non-participation and not adopted | 12 | 25.5 | 0 | 0 | 0 |
| Total | 47 | 100 | | | |

1.2. Rate and degree of adoption in the sample as type and source of the technology:

Results showed that rate of adoption of improved male between sheep raisers in the villages of study concerning source of technology reached 25.5%. Same rate of adoption came from the non-adopted farmers. That may show that some farmers have not got a way to use the improved male of sheep in mating with their female sheep. However, degree of adoption was higher level, 19.3, between farmers that used their own male, mating with male from different villages. This result can support the idea of increasing the knowledge between farmers about the improved male might have a very positive impact on increasing rate of adoption. While result of density of adoption was the highest, 4.8 comparing to 2.6 own male and 2.9 other farm. In fact adoption rate may be increased if the Research Station had matured improved male during 2014-2015.

Table 2 Distribution of farmers' by type of source of technical

| Source of technology | Number | Rate of adoption | Degree of adoption | Density of adoption |
|---|---|---|---|---|
| Improved Male | 12 | 25.5 | 19.3 | 4.8 |
| Owned or Bought Male | 7 | 15 | 17 | 2.6 |
| Male From other Farm Used | 16 | 34 | 8.7 | 2.9 |
| Not Adopted | 12 | 25.5 | 0 | 0 |
| Total | 47 | 100 | | |

1.3. Rate and degree of adoption of improved male of sheep by farm size;

Other type of study was on rate and degree of adoption of improved male sheep by farm size. Result showed that higher rate of adoption was found when flock size is small (1-25) and lowest rate was when flock size is big (>75). In degree of adoption highest degree of adoption was when the flock size was big and the lowest degree of adoption was when the flock size is smaller. It could be concluded that holders of small flock size are keen to improve their sheep production while holder of big flock do not mind the risks since they have many sheep. Flock size 25-50 showed highest rate of adoption and degree of adoption. Density of adoption recorded the highest value with the farmers with small flock.

Table 3 Rate and degree of adoption of improved male of sheep by farm size

| Flock size (head) | Number of Farmer | Rate of adoption | Degree of adoption | Density of adoption |
|---|---|---|---|---|
| 1-25 | 14 | 30 | 4.9 | 6.1 |
| 25-50 | 18 | 38 | 8.5 | 1.9 |
| 50-75 | 8 | 17 | 10.4 | 1.4 |
| >75 | 7 | 15 | 20.5 | 1.6 |
| Total | 47 | 100 | | |

1.4. Dissemination of adoption mating with improved male of sheep

In order to identify the rate of dissemination following formula was used:

$$Y_t = \frac{K}{1 + e^{2022.04 - 0.113}} \qquad (4)$$

Figure (1) showed that rate of adoption with improved male of sheep reached 74.5% up to 2015. Meanwhile expected rate of adoption was 85% at the same period, 2015. This may indicates a gap between the existed rate of adoption and the expected theoretically. The sample of analyses is expecting the adoption rate of mating with improved male of sheep may raise up to 94% at 2025.

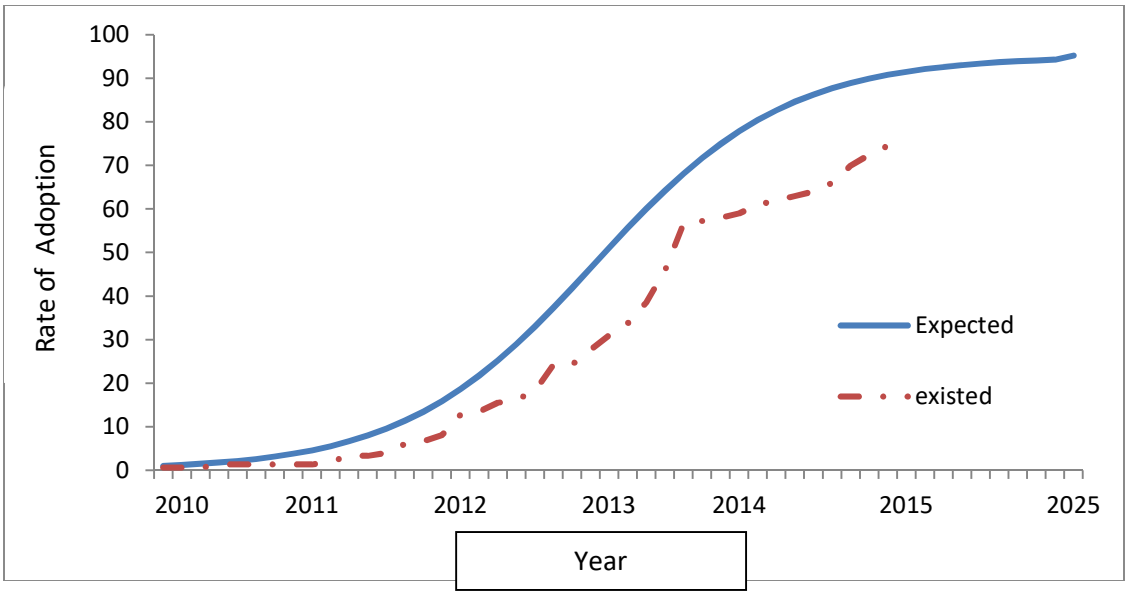



Figure (1): Rate of adoption existed and expected of improved male in mating

**2- Economic impact of mating with improved male of sheep**

Economic impact of mating with improved male of sheep was found on increasing weight of born lamb with 33% comparing to mating with farmer male of sheep, increasing of mating efficiency and decreasing of number of lamb death and showed increasing in weight of sheep at age of 3 months which is the preferable age for selling with rate of 28%, that had a real impact on price and farmer income.

2.1. Cost and benefit analysis (C/B):

Cost and benefit analysis was related to the increase in size and weight of lambs that led to increase in price at selling time and compared to cost of using improved male in mating. That will lead to calculate the Internal Rate of Return (IRR) which represents the lower rate of return on total fund invested in the technology.

In this study, (C/B) will depend on increase in meet production of lamb weight 12 kg to 15 kg/lamb/year at 3 months age and increase in weight 25 kg to 30 kg/lamb/year at age of 1 year.
- period of five years as a period of using and raising improved male through 2010-2016

- Rate of 10% as benefit price with Banks.

C/B calculated with following formula:

$$B/C = \Sigma(B_t/(1+r)_t / \Sigma(C_t/(1+r)_t \quad (5)$$

Where:

$B_t$ Annual Income

$C_t$ Annual cost

r = discount rate

IRR is the discount rate for which B – C = 0.

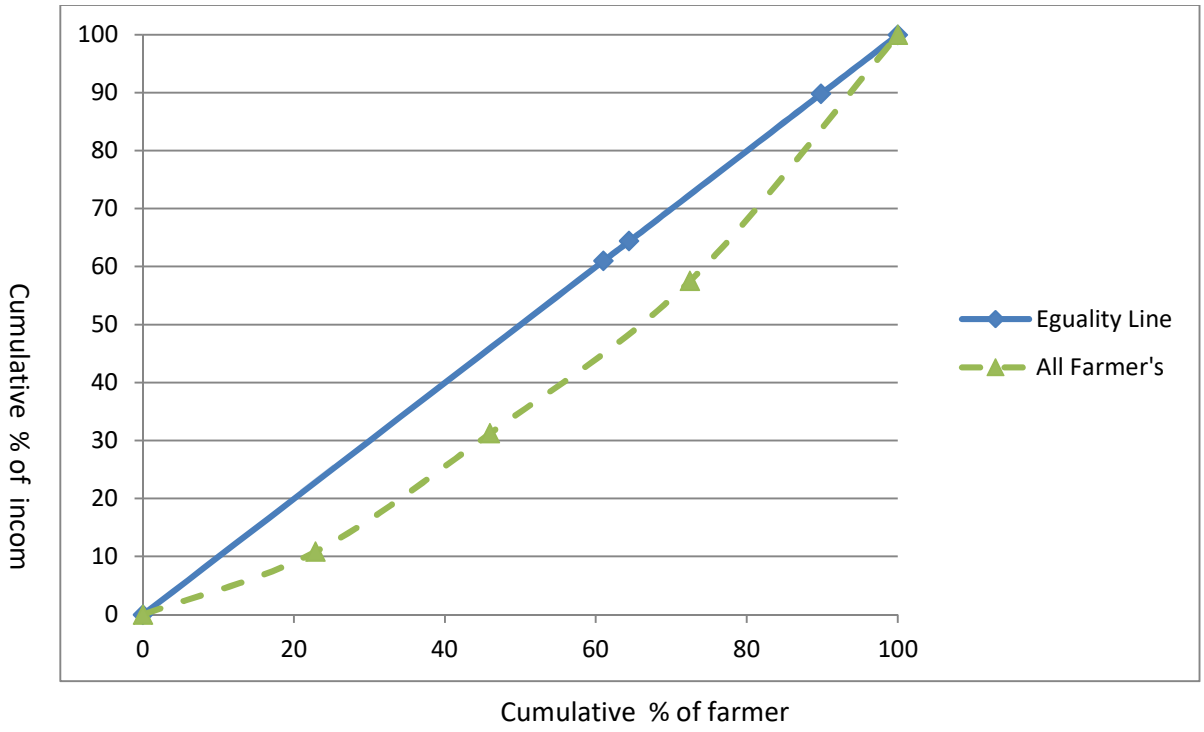
According to using the mentioned formula and from table (4), C/B was 4.36% and IRR was 52%. That may indicates higher return when using improved sheep in mating with 436 Real for each 1 Real used. Higher Internal Rate of Return Which has been calculated at discount rate 10%.

Table 4 Benefits and costs of using improved male in sheep

| Year | Annual Sheep Production (number) | Annual Benefits (000 RY) | Annual Costs (000 RY) |
|---|---|---|---|
| 2011 | 77 | 0 | 51.92 |
| 2012 | 129 | 413.25 | 86.53 |
| 2013 | 207 | 661.21 | 138.44 |
| 2014 | 232 | 743.86 | 155.75 |
| 2015 | 258 | 826.51 | 173.05 |
| Total | 903 | 2644.83 | 605.69 |

2.2. Lorenz curve:

Lorenz curve shows the differences in distribution of income through describing the gap between equity line and the real distribution or measuring the variation in inequity of family income.




2.3. Gini Coefficient:

Lorenz curve show the equity distribution graphically, while Gini coefficient show the equity numerically. Gini Coefficient reveals the results between 0 and 1, and when value between 0 and 1 is small indicates variation in income distribution is low and vise-versa. Application the following formula, results showed that Gini Coefficient for distribution income was 0.67804 which mean there is variation in distribution of income between the surveyed farmers. Variation of income distribution can be related to many reasons such as farm size, number of livestock owning and good link mechanism to the market.

Following formula:

$$G = |1 - \sum_{k=0}^{k=n-1} (X_{k+1} - X_k)(Y_{k+1} + Y_k)|$$

G: Gini coefficient

X: cumulated proportion of the population variable

Y: cumulated proportion of the income variable

2.4. Factors affecting adoption improved male in mating

In order to study the factors affecting adoption of improved male of sheep, Binary Logistic method was used. Also, WALD test was used to identify the importance of Binary logistic.

Table 5 Variables in the Equation

| | Independent variables | B | S.E | Wald | Sig | Exp(B) |
|---|---|---|---|---|---|---|
| (X1) | Age | 4.31 | 2.45 | 3.085 | 0.079 | 74.5 |
| (X2) | Education | 1.33 | 1.05 | 1.595 | 0.207 | 3.79 |
| (X3) | Area | -0.09 | 0.52 | 0.030 | 0.863 | 0.913 |
| (X4) | Price | 6.83 | 3.40 | 4.038 | 0.044 | 933.6 |
| (X5) | Total Income | 0.35 | 0.48 | 0.54 | 0.462 | 1.42 |
| (X6) | Family Size | -0.68 | 0.85 | 0.643 | 0.423 | 0.502 |
| (X7) | Flock Size | 1.17 | 1.17 | 0.334 | 0.564 | 0.508 |
| (X8) | Sheep Weight | 7.15 | 3.36 | 4.515 | 0.034 | 1285.4 |
| (B0) | Constant | -39.58 | 18.01 | 4.827 | 0.028 | 0.000 |

a. Variable(s) entered on step 1: Age, Education, Area, Price, Total .Income, Family. Size, Flock. Size, Sheep. Weight.

Results obtained showed that weight of lambs (X8) represented the first priority since it showed 7.159 regression coefficient and significance in affecting the dependent variable at 0.05. Wald statistic results showed 4.515 likelihood rate, and Exp(B) value was the highest (Table 5). Those results may reveal that weight of lambs was the most important factor and an increase in 1 kg in weight led to 1285.49 times in likelihood rate of adoption.

Price of sheep recorded the second factor in affecting dependent variable since it showed 6.839 regression coefficient. Wald statistic results showed 4.038 and Exp(B) value was the found to be 933.66 likelihood rate of adoption. Other variables such as age, education and total income has no significant in affecting dependent variable although age variable recorded high Wald value (3.09) (Table 5).

Conclusion:

Adoption of the improved male technology showed a respectable standard. During farmers discussion, some factors that may acted in slowing the adoption. Limited facility in the Research station to produce enough improved male at a time and longer time takes to produce the improved male of sheep which takes between 10-11 months.

Farmers now came to the research station to buy and/or reserve improved male to be used in mating to improve their sheep production.

Since Telhamah village was the first village and involved in the project activities during phase I and II, farmers are aware more than other on the importance of the technology and most impact of the technology was in this village.

Participated farmers in the new villages, Mankadah and Al-Hijrah appreciate their involvement in the project activities, mainly in improve male of sheep. They have an idea about the impact of the technology in first village Telhamah.

**General Conclusion:**

Introducing of improved male of sheep technology to Telhamah village during project phase I and to other two villages, Bani-Saba and Al-qubah, during 2014-2015, project phase II had played an important role in disseminating the technology and a good impact on improving sheep production. During the period of 2010-2013, main impact were improving lambs, weight and health, produced from mating with improved male of sheep and sold with higher price. Price was almost double, comparing to lambs produced from mating with farmer male.

Simple concentrated feed recipe played an important role in improving mothers and their offspring health. Training courses on preparation concentrated feed conducted at the five villages during 2016 no doughty will have a positive impact on farmer knowledge and skills on improving livestock nutrition and production.

Personal communication revealed that farmers from different villages are often come to the research station to buy improved male of sheep. If the research station in the Central Highlands improved their production of improved male program, improved male technology may have disseminated to more areas and villages in the location. It should be said that field days played a good role in revealing the source of improved male production to farmers.

Since 75% of national research program in Yemen concentrating on improving plant production issues, this project has an important inputs to the livestock research program in two ways; firstly realizing the importance of livestock breeding, mainly improved male, disseminating the technology to more farmer areas with following up to the performance.

# FINAL REPORT TSELMA PLAN PROJECT 2014 – 2016

**TITLE:** - AGRICULTURA PRODUCTION SYSTEM FOR THE POOR AND VULNERABLE IN DRY AREAS (IFAD Funded Project).

## National Agricultural Research Institute of Eritrea

INTRODUCTION

NARI in collaboration with different partners recognized the critical role of crop seeds in agricultural transformation. Crop seeds play a critical role in increasing agricultural productivity and also determine the upper limit of crop yields and the productivity of all other agricultural inputs in the farming system. Eritrean farmers are highly initiated to take the opportunity with full preparations and work in collaboration with Ministry of Agriculture (NARI). Contribution from IFAD as a development partner on foundation seed production program is an advantage to launch crop seed multiplication programmers

- **Objectives:-**Enhance smallholder farmers' livelihoods through innovation Research to Business (R2B) platform.
- **Target Group:** smallholder's farmers in Tselema plain in five villages within sub zoba Debarwa.

**Project Components**:

**Component 1**: Improving smallholder farmers income through improving

productivity and establishing business platform and scaling up of the businesmodel in Tselema plain.

**Objectives:**

- Establish a sustainable and model research to business platform.
- Strengthen linkage among different actors.
- Enhance technology multiplication and dissemination.
- Build the capacity of the various actors
- Enhancing household and national food security.
- **Beneficiaries**: 310 farmer will be benefited from project and 2800 households as indirect beneficiary.

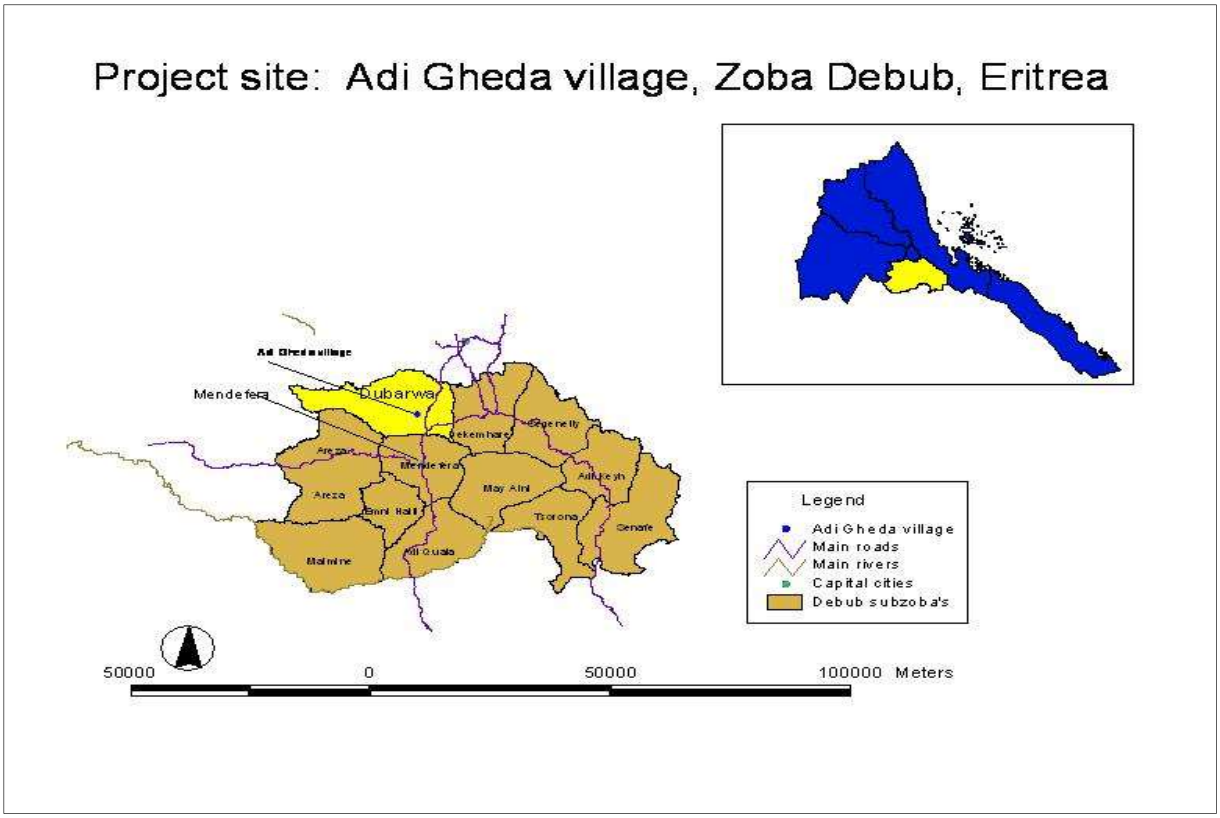
**Technology package to be scale-out**

- **Technology package 1**: Improving farmers' income from improved Wheat production through linking farmers to a Millers/factory for sustainable market.

**PROJECT AREA DESCRIPTION**

- The potential project area for intervention includes the Tselema Plain in five villages of zoba Debarwa. This Village has been selected due to availability of suitable climatic and soil types' for staple crops seed multiplication. The total population of Tselema plain is 82,000 and there are 82 villages with this locality. The total household in the five villages is 2800, but these number is

increased by 500 (3300) because additional farmers are add. Tselema plain will be organized as producers of wheat seed.




| Villages | No of Farmers | Area planted/ha | Amount seed/qt | DAP/qt | UREA/qt |
|---|---|---|---|---|---|
| Tera-emini | 78 | 41.75 | 41.75 | 41.75 | 22.00 |
| Adi-Geda | 78 | 26.3 | 26.3 | 26.3 | 12.00 |
| dubaraw | 50 | 43.3 | 43.3 | 43.3 | 19.65 |
| Emin-tselim | 56 | 29.8 | 29.8 | 29.8 | 15.9 |

| | | | | | |
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| Takita and giula | 48 | 18.85 | 18 | 18.85 | 9.0 |
| **Total** | **310** | **160** | **160** | **160** | **80** |

In the 2015 rain season 310 farmers from 5 different villages of the sub-zoba dubarwa were provided seeds of improved Wheat varieties with full package of fertilizer. The 310 farmers received 160 quintal of improved seed ,160 quintal of fertilizer DAP,and 80 quintal of Urea. All the farmers planted the improved seed in the mid of July 2015 because of the late starting of rain. But the farmers the farmers with supplementary irrigation planted at the end of June and beginning of July. This year due to shortage of rainfall in the rain fed fields of the project site the harvest was be below the average. To overcome this problem in the off season of 2016 extra 20 hectare was planted, from these 800 quintal harvested. In 3 villages 120 farmers will be added in the rainy season of 2016 therefore the total population in eight villages is 3300.

MAIN ACHIVEMENTS

- The project achieved its goal by establishing community based seed production where farmers will produce ample amount of improved seed consistently.
- They started to supply wheat grain to the mill company up to 12, 400 quintal per year; this will increase every years when the number of farmer and area of land increase.
- The numbers of beneficiaries increased by 10% per year, that means the country can decrease the exported wheat every year by 20%.

- Livelihoods of Rural Communities Improving through Sustainable increasing of production and productivity.
- The final goal of this initiative is to increase the production and productivity of crops, thereby enhancing household and national food security.

## Inception workshop

To start the project local inception workshop was conducted in Halhale. In the workshop 61 participants that include administrators, researchers, extension agent and farmers from the district of Debub and sub-zone were invited and participated. In the inception workshop Farmers, extension researchers and policy official were attended.

In the workshop, opening speech was given by Dr Iyassu Ghebretatious (Director General of NARI). In his speech the strategies of NARI toward foundation seed, its importance and benefits of farmers form the project was explained. Detailed information about the project actives was presented by the coordinator of the project and Director of the crop improvement Mr. Tsegay berhane. Regarding the livestock activities director of the livestock division Dr Tsegay Tesfay gave a brief presentation on the live stock aspect. At last Questions, comments and constructive ideas for the success of the project was forwarded from the participants.

Establish and operationalize innovative R4D activities in **Gash-barka** areas of Eritrea for promotion and dissemination of best bet bread wheat technologies in farmers field with the involvement of stakeholders along the wheat value chain

## Baseline survey

Base line survey was conducted in adi-geda village. The questioner was field by 50 farmers form the village. The survey considers varieties of people which include 20 from elders, 15 women and 15 young farmers which have considerable experience in the field of farming.

Socio-economics and Farming System Research Unit of NARI took the responsibility to collect qualitative and quantitative baseline information about production and productivity of major crops, farming practices, soil fertility and SWC measures, post-harvest management, awareness and knowledge of farming communities on released crop varieties, household income, etc and subsequently produce this survey report.

**Capacity building**

One day Training on wheat production, field management was t was heldon the 19th November, 2015 in Asmara. The training was organized for farmers, extension and researchers. It was given by Tesfu Isaac, TekleTafere, MichealYakob (from National Agricultural Research Institute (NARI)) and GhenetGhebrezgeabhier(from Makeal region Extension). Topics covered in the training was Wheat seed, Land preparation, sowing method and wheat , Fertilizer application, wheat disease, weed and its control, Harvesting and storage and wild oat. Here the interaction of all participants was great and especially interest and participation of farmers in the discussion was outstanding.

**Farmers field day** Farmer's field days were conducted. DG of Agriculture, Land and Water Resource of Maekel region attended the field day. Other participants including Director of Extension, Director of the crop improvement, extension agents, researchersand farmers attended. Total of 163 participants attended. Right after the field day H. E Minister of Ministry of Agriculture, DG of Agricultural extension, DG of Crop and livestock Corporation and other high officials had visited the IP fields in Maekel region. The field day has brought together 163 participants of multidisciplinary team composed of Farmers, wheat breeders, agronomists, soil scientists, pathologists, socio-economists, extension officers, policy makers, loan and credit officers, mass media and representative of seed releasing committee.

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Stakeholders meeting were conducted. DG of NARI, DG of Agriculture and water and land resources attended the in the meeting. Other participants included: Head of Crop production, 16 extension agents, 7 researchers and 12 farmers participated.

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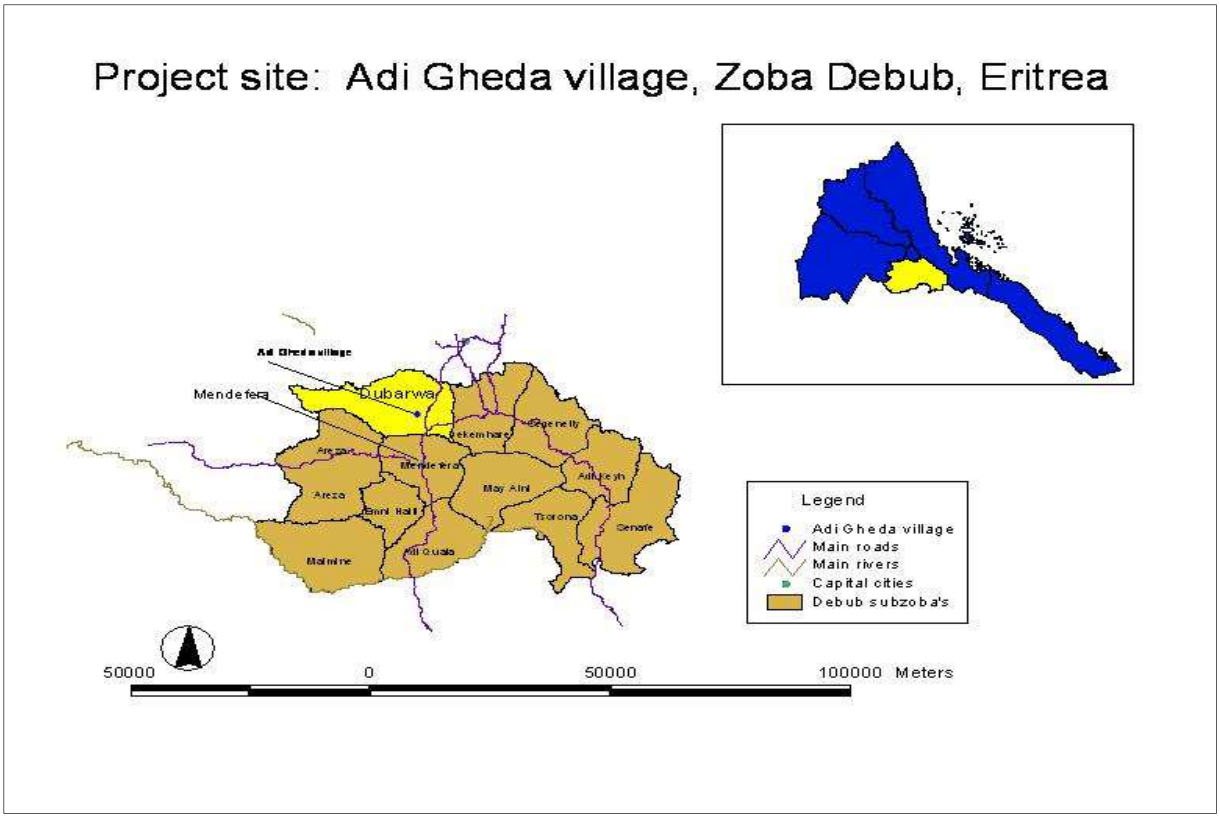


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