Projet Villages du Millénaire

# Toya irrigation Socio-economic study

**Alpha Oumar KERGNA**
**Mamadou Kabirou N'DIAYE**

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# Executive Summary

The Toya cluster funded by the Millennium Development Goals project is located in the commune of Alafia in Timbuctu region. The commune has a total population of 12624 inhabitants and their major activities are cropping and herding.

Poverty is dominant in the area and is reflected by food insecurity in almost the totality of households. No household in the area lives on its own production during a full year and only 10 % of households are able to satisfy their food requirement during 8 to 9 months from their own production.

The area has large potentialities for agriculture and livestock. The irrigation team reported a total potential of 8489 ha. This potential includes 1313 ha that could be developed by the population in PIV; 2381 ha of plains which could be developed in the long run; 3680 ha of swamps and low land valleys and possibilities of 1115 ha for burgu culture.

Farmers in the area crop rice, millet, sorghum, potatoes, shallot, tomatoes, etc. but harvest poorly because they don't have access to fertilizer, improved seed and good extension services. Farmers crop only once a year, while they could crop at least twice.

For farmers to be able to produce enough irrigation system should be built and farmers organized to achieve collective actions. Farmer should also be equipped to crop larger plots and produce staple food during the main season and market crops during the off season.

The issue is not only increasing production but also allowing farmers to access processing techniques, storage practices and market. These outcomes could not be achieved without investment in different domains such as infrastructures building, organisation of farmers, transportation, equipment etc.

Huge investments are necessary to achieve expected results. An analysis of different investment options proved they are profitable with internal return rates (TIR) of 25 to 126 %.

There are many market potentialities for products grown in the area and access to those will help farmers reduce their poverty level by selling at better prices and getting input at low costs. A larger production will also reduce food crop prices variability and make them accessible to population in the area.

# I. Background

## 1.1 Physical aspects

### 1.1.1 Location

The rural commune of Alafia created by Law n° 96-056 is within the Timbuctu circle and covers the Northern part between 15ième and 25ième parallels of latitude North. The Alafia commune equals in its' configuration and extent the old administrative division of central Timbuctu. The commune area is 27 857 km² representing 8,01 % of the circles' territory.

The commune is limited North by Algeria, South by the communes of Garbakoïra and Haribomo, South-East by the communes of Bourem Inaly and Lafia, East by Salam and West by the communes of Douékiré and Essakane.

The commune is situated in the sahelo – saharian bank and is divided into two distinct zones: a heavily populated zone at the river bank where the soil is clay to silt and an almost empty zone in the sahelian part where ergs or dunes are predominant. The vegetation is poor with some woody and herbaceous species.

### 1.1.2. Seasons

Two seasons are dominant in the commune: one rainy season from July to September and one dry season from October to June. Temperatures vary between 10 degrees minima and 45 degrees maxima. Temperature differences are more important in the northern part of the commune where they can be around 5 degrees during winter (December to January) and above 45 degrees during dry season. Rainfalls in the commune are irregular and for a short period, they are rarely above 150 mm during a year unless exceptional ones. The following table gives the amount of rainfall and the number of rain days from 2000 to 2005.

### 1.1.3. Rainfall patterns

**Table 1: Amount of rainfall and rain days from 2000 to 2005**

| Years | Amount of rainfall in mm | Number of rainfall days |
|---|---|---|
| 2000 – 2001 | 26,10 | 22 |
| 2001 – 2002 | 119 | 20 |
| 2002 – 2003 | 139,4 | 24 |
| 2003 – 2004 | 250 | 26 |
| 2004 – 2005 | 146 | 15 |

**Source: Rapport PDSEC Alafia**

### 1.1.4 River level over the year

The Niger River and its dependants are main water sources for irrigation. Traditional agriculture production is based on flood crops (flooded rice, bourgou) and flood recession crops such as maize, sorghum, millet, potatoes, cassava, etc. Productivity and production levels depend heavily on the flood in this later case. Since drought periods, when flood level in the river decreases considerably, population adopted irrigated agriculture based on PIVs. During the season, from July to December the level of water in the river is relatively high and it is low during off season (January to June).

There are three main river based water sources in the commune: the Niger River which serves villages such Toya, Djéeguélia, Homdoubomo and Iloa ; the Tassakane River serving Issafeye Douékiré, Issafeye Dongho, Tintelout et D'Ag Hamzane and the Daye which serves Djéguelia, Hondobomo et Iloa. These water sources last at least three months after flooding period.

### 1.1.5 Soils, etc.

**Soils:** The commune is situated in the sahelo – saharian bank and is divided into two distinct zones: a heavily populated zone at the river bank where the soil is clay to silt and an almost empty zone in the sahelian part where ergs or dunes are predominant (sandy soils). The vegetation is poor with some woody and herbaceous species.

## 1.2 Population structure

### 1.2.1. Overall size

The 1996 census estimate the population of the commune to 12624 inhabitants with 6186 males and 6438 females. The following table provides population information by village in the commune.

**Table 2: Population of different villages in the commune**

| Villages | Population | | Total |
|---|---|---|---|
| | Male | Female | |
| Ilao | 720 | 749 | 1469 |
| Hondobomo Koina | 769 | 800 | 1569 |
| Djéguelia | 405 | 421 | 826 |
| Toya | 782 | 814 | 1596 |
| Tassakane | 405 | 422 | 827 |
| Issafeye Douékiré | 305 | 317 | 622 |
| Issafeye Donghoi | 107 | 112 | 219 |
| Tintelout | 384 | 399 | 783 |
| D'Ag Abazanga I | 324 | 337 | 661 |
| D'Ag Abazanga II | 655 | 682 | 1337 |
| D'Ag Bohdel | 100 | 105 | 205 |
| D'Ag Alal | 53 | 56 | 109 |
| D'Ag Ibni | 65 | 67 | 132 |
| D'Ah Hamzane | 97 | 100 | 197 |
| Ikounadene | 87 | 91 | 178 |
| Tillemedess I | 103 | 108 | 211 |
| Tillemedess II | 132 | 137 | 269 |
| Tillemedess Inkarane | 85 | 88 | 173 |
| Taglift Inkarane | 95 | 98 | 193 |
| Kel Tineguel hadj | 236 | 245 | 481 |
| Kouloutane Haoussa | 278 | 289 | 567 |
| Total | 6187 | 6437 | 12624 |

**Source : Commune general secretary book**

The 7 villages of the Toya cluster forming the grape of millennium village has a population estimated to 5 668 inhabitants. The 2/3 of this population are located in the following villages: Iloa, Hondomo Koina, Toya and the D'Ag Aazanga II fraction. Five ethnic groups compose the population and in terms of number Songhoi dominates followed by Tamacheq, fulani and Bozo. Major population activities in the commune are cropping and herding.

### 1.2.2 Households

In the commune there are 1639 households. Large families are the back bone of the society in the area. Now days, these large families split in all villages and nomadic fractions and give small households. Decisions are made by the heads of small families regarding to engagement of their household in any kind of activity.

The social rank of a household is very important in the village concerning decision making. Households coming from the family which found the village, or chief of the village usually decide about land allocation and its' uses.

Households in the cluster area lack of farm equipments and have little workforce at certain periods of the year. The head of the household is the oldest male or female, but the number of male household head is larger than that of females.

Farm works are done by both men and women in the household; some activities are known for men (plowing, harvesting, transportation, etc.), other activities are meant for women (winning). There are activities done by both men and women (seeding, threshing, planting…).

Most of households in the cluster area are not self sufficient, they rely on transfers from migration and off farm activities.

### 1.2.3 Household size

The size of households in the commune varies between 3 people to 5 people. Smaller household size, lack of equipments and costs of resources make farmers unable to crop large field sizes and diversify their activities. Rice farming is highly intensive in the PIVs, therefore requires more labor force or enough of monetary resources for efficient farming.

For some farm activities households have to do them collectively (help groups).

### 1.2.4 Age groups, gender, etc.

Total population of the cluster was 8546 persons in 2004 with 4358 women (51 %). The number of women out passes the number of men only in the 15-35 years range. For older ranges the number of men is slightly higher. The commune population is young; the range between 0 to 14 years represents more than 50 % of the population and 15-35 years accounts for 29 % of it. This last category constitutes the labour force. Labor is not a constraint because the household provides on average 50 % of it for agricultural tasks and the other half is hired but paid in kind during harvest.

| Sexe | Pop 98 | | Pop 2004 | | | |
|---|---|---|---|---|---|---|
| | 15-35 | 36-59 | 60 et + | 15-35 | 36-59 | 60 et + |
| H | 958 | 700 | 258 | 1089 | 796 | 293 |
| F | 1260 | 687 | 229 | 1438 | 784 | 261 |
| Total | 2218 | 1387 | 487 | 2507 | 1580 | 554 |

**Place of women in the society**

Women, whether at village or communal levels participate rarely to decision making. After their reproduction role, they are used as labor force in agriculture. Within an organization, they are not represented at decision making level. However, women play a big role in the economic structure of villages and fractions: they participate at the family income generation through agricultural activities, arts and small scale trade.

Constraints to women mainstreaming in the Alafia commune are:

- the weak education level of women,
- the weak organizational level of women associations,
- the lack of production and processing means,
- the weak access to decision making structures,
- bad organization of first needed products supply,
- the weigh of tradition and religion.

## 1.3 Social organization

In the area there are 81 associations covering several areas of development. Among these associations 50 are functional (their aim is to get funding) from different donors. Associations meant for agricultural purposes are 42 among which 15 are women associations. The project is elaborating protocols with these associations and most of the content comes from beneficiaries.

## 1.4 Land access

In Mali, land belongs to the State. Land is leased for long periods of time and can be inherited. The land tenure system is characterized by the coexistence of customary law and the State land code. The 96.050 Act makes possible for rural land to be transferred from Government management to decentralized territorial authorities, while the 2002-008 code on the State Land and Forestry gives greater recognition to customary laws and practices. The 01-004 Act on the Pastoral Charter establishes the fundamental principles for livestock activities and defines the rights of access to pastoral resources. The management of land resources is the responsibility of territorial communities in conjunction with traditional authorities, professional associations and local technical services. Most disputes and conflicts surrounding land tenure issues are usually solved at the local level.

### 1.4.1 Area under current cultivation

Land property is traditional, it belongs to the first settler in the village who allocates to other families space on which they keep rights on until they cease to use it. They can't donate or sell the land; but can borrow or lend it with right recognition to the owner by paying fees in cases. Land availability is not a constraint in the commune of Alafia for the agricultural production. Each village has at least one to two PIV with area ranging from 10 to 50 hectares in general. Some villages have land in the schemes of the Daye Amadja Project. In Toya the largest perimeter is 104 hectares, but only 70 hectares are farmed. The whole perimeter is not farmed because of non payment of water delivery fees by some producers.

The village of Tassakane with about 300 hectares is the one having the biggest developed PIV land in the commune with an average of more than 2 hectares by household. To attain profitability in a sustainable manner, households need significant amount of resources (financial, labor, etc.). Since resources are scarce, extensive cropping systems are used by farmers.

Despite high potentialities, land management between farms and pasture lands is a big constraint. During the off season, all herds graze in the PIV areas in different villages; this limits sometimes possibilities of double cropping or crop diversification. Farmers' reaction to the situation is to give up systematically off season cropping avoiding conflicts which can have serious consequences.

### 1.4.2 Potential new areas

Large possibilities of extension exist in the area according to the irrigation team report. The team reported a total potential of 8489 ha. This potential includes 1313 ha that could be developed by the population in PIV (the team also did a detailed study on 500 ha of PIV); 2381 ha of plains which could be developed in the long run; 3680 ha of swamps and low land valleys and possibilities of 1115 ha for burgu culture.

Knowing potentialities within the region and food difficulties, the Millennium Village Project based in Toya decided to assist the villages of Iloa, Djéguélia, Toya, Tassakane, Issaffaye Dongoï, Issaffaye Douékiré and Dag Alal fraction for self-sufficiency and poverty reduction. One of the projects' goals is extending irrigation perimeters. The following table 3 gives areas of existing perimeters and possible extensions.

### 1.4.3 Plot sizes, locations, ownership, management

*Ownership, management*

Land tenure is traditional, it belongs to the first settler in the village who allocate to other families space where they rights on until they cease to use it. They can't donate or sell the land; but land can be borrowed or lent with right recognition and depending on agreement fees could be paid to the owner.

**Table 3**: Sites and their areas

| Circle | Commune | Village | Site | Existing PIV area (ha) | Extension area (ha) |
|---|---|---|---|---|---|
| Tombouctou | Alafia | Iloa | Far far | 40 | 26 |
| | | | Dale Téhéré | 33,69 | 0 |
| | | | Saragna | 9,56 | 0 |
| | | | Abatoubangou | 6 | 8,32 |
| | | **Tassakane** | Sororia | 40 | 65 |
| | | | Bandoubanda | 34 | 0 |
| | | **Toya** | Bafundou | 106 | 0 |
| | | **Issa fèye Dongoy** | Lafia | 20 | 3 |
| | | | Bangoubando | 20 | |
| | | **Isssafèye Douétiéré** | Darey | 50 | |
| | | **Djeguélia I** | Kandjigua | 55,25 | 14,62 |
| | | **Djeguélia II** | Hondo Tchabya | 14 | |

**Source: Topo survey 2008**

Among the 12 PIV sites, extension is possible in only 5. The extension area distribution areas vary depending on PIVs from 3 to 65 ha. The following table gives the infrastructure and equipment status on existing PIVs.

## 1.5 Current cropping system (s)

The current cropping system in the Alafia commune is based on rice monoculture. However, in nomadic fractions, the primarily activity is pastoralist. Producers give priority to rice production even when diversification is possible. Very little experience has been developed on other crops by farmers. Also, double cropping or triple cropping on the same field is not a current practice even when water is not a constraint.

### 1.5.1 Farm sizes

Our investigation in different villages proves that farm sizes are small in PIV (between 0.25 and 0.37 ha by household), while farm sizes are relatively big in other cropping areas (between 5 and 10 ha by household in plains and low land swamps). The team noticed also that households possess plots in several PIV in the same village and some households have their own PIV.

Farm size depends on social status of the household in the village (fonder of the village, chief of the village, wealth status, migrant, etc.). There are households which don't possess land in the area (this aspect will be developed in later chapter dealing with land access).

### 1.5.2 Main crops

Main crops are rice, millet, sorghum, cowpea, cassava, sweet potatoes, wheat, etc. These crops are grown on indifferent land areas. Rice is grown mostly in irrigated lands: PIV, swamps and low lands and plains; irrigated by the river and its dependants using a canal system or not. Wheat is irrigated only by canal system. Crops such as millet, sorghum and cowpea are rain fed or using flood residual moisture. Cassava and sweet potatoes are grown only using residual moisture.

On PIVs farmers produce rice mainly for consumption, only the surplus is traded within the village or neighbouring villages. Rice is produced on small areas in PIVs (0.25 ha/ farmer) by pumping water through a canal system, using high productivity varieties and fertilizer.

Vegetables are produced as secondary crops in the cluster predominantly by women, at a very-small scale. They use gardens between 0.5 and 2 hectares, equally distributed among households in a village. These gardens are located near villages. They are fenced in some cases and have a functional borehole meant for irrigation purposes. Vegetables grown in the area are: Irish potatoes, lettuce, tomatoes, pepper and onions.

### 1.5.3 Current use of pumps and number of pumps

In the area there are many pumps makes; the most popular ones are Deutz, Hatz, Peter/Lister, Lombardini, Anyl and KSB for rice and wheat irrigation; and treadle pumps (CIWARA, MoneyMaker, etc.) for vegetable watering. These later pumps are usually given by project supporting women associations in villages which have permanently access to water (river or wells with a depth not more than 7 meters). To date there are 17 GMP in the cluster area and all of them are functional (but they are obsolete). Motor pumps are over used and in some cases they function 24 hours/days during growing periods because the irrigation networks are deficient and loose a lot of water. Since motor pumps are obsolete, they consume important quantities of fuel which make production costs very high.

In villages concerned by the project, PIVs have an irrigation network built with beneficiaries' participation. Canals are in earth and are not efficient (require heavy maintenance). Such a system is cheap but not sustainable because will end up with enormous water losses, therefore more burning of gas, oil consumption and long time pumping for irrigation.

Pump maintenance is a big constraint for PIV associations in the commune. They don't have access to spare parts, good mechanics and are not sufficiently trained to apply requirements for protecting pumps.

### 1.5.4 Current storage system

Currently, in villages, rice is stored in paddy form by household in granges built for the circumstance. In some villages, PIV association members built storehouses where they keep the paddy collected from water fees payment and credit reimbursements. Some of the storehouses have relatively large capacities (up to 500 tons). The paddy is conditioned in 100 kg bags.

Storehouses are built in mud and most of them is non functional in villages. Also, the stock doesn't go through any treatment (chemical or traditional) before it is stored in storehouses and as a consequence many bags are destroyed by moisture, rats, insects, etc.

### 1.5.5 Current sourcing of inputs

Inputs used by farmers in the area are: improved seeds, fertilizer and manure. Most of producers, use as seed part of their production, this is true for rice and other crops (vegetables) production. Usually, projects supply their village members with improved seed ordered from research stations or other seed producers (farmers in the cluster not having access to improved seed).

Farmers could be trained to be seed producers and supply other farmers within the area. But since they don't have access to fertilizer in nearby markets and even if so, quantities are not enough and cost very expensive; they should get assistance for the purpose. Farmers who use fertilizers do it in small quantities and partially (instead of using urea and DAP, they use only one of them). Fertilizer is usually provided by supporting services in the area; because of a bad road system and constraints related to fluvial transport, the few amount of fertilizer reaching the area gets in late, when its' application date has past. There are no fertilizer traders in the project area.

Because of the lack of relevant transportation equipments, farmers don't use manure in their fields even though they possess animals. Also farmers are not trained in how to use efficiently crop residues or how to make compost. These alternatives techniques could improve actual farm production and reduce production costs.

### 1.5.6 Current pricing model and overall production costs

Farmers were able to talk about only rice price and cost. The other crops are grown in very small scales.

The pricing model is based on supply and demand. Prices are low during harvest and high during the rainy season (when staple food is scarce). They sell their produces on weekly markets in their village or in neighboring villages. Produces are sold in “pot” equivalent to 1.5 kg. During harvest time the price of a “pot” of paddy ranges between 125 and 175 CFA and during the rainy season between 250 and 350 CFA.

Farmers sell at a very low price during the harvest period most of their production to pay for water fees or to reimburse credit or to pay for per capita taxes. This need of cash at that time makes farmers weak bargainers.

The lack of a credit system dealing with crop storage in the area makes farmers selling at low price and buy latter at higher prices. This situation benefits more the traders who are also closer to farmers.

### 1.5.7 Current buyers and sellers of the products

There are many buyers in the area, but any of them isn’t able to influence price levels. The amount they buy ranges between 4 and 6 bags of paddy a week. They operate individually (some times they use an intermediary) and quantities bought depend mostly on the amount of money in hand.

Major buyers of the produces are the population in the area of the project: however, part of the production is sold to buyers from Timbuctu, Gao and Mopti.

Our discussions with actors involved in rice value chains indicated that major buyers are farmers from other areas and small scale traders. These traders are from Timbuctu, Mopti and Gao who collect the paddy using intermediaries. Most of the time, quantities required by relatively big traders are not available in villages storehouses; therefore small traders supply the ones who dominate the market.

Buyers get also products from producer associations. Associations collect water fees and credit reimbursement in kind from their members and sell it latter. The price at which they collect the paddy is higher than the market price; therefore, the paddy ends up being very expensive at the time they want to sell it. This type of problem made many associations unable to meet engagements with financial institutions and suppliers. These buyers some times mill the paddy before selling it to the end buyers who are households.

Sellers are individual farmers who sell small quantities weekly or monthly to satisfy at family consumption expenses. There are also village collectors who are also farmers but do this trading to make extra income. All individual

sellers are small scale sellers. Cooperatives or associations sell rice to traders. Most of the time, we hear organizations saying that they were not able to sell their rice. This is true because associations or cooperatives when they pay water fees or reimburse credit over price their paddy.

### 1.5.8 Overall profitability of the system

The system as it is presently is not very profitable according to the crop budget built for rice. This non profitability could be explained by several reasons: lack of canal lining, over use of pumps, lack of improved seed, and lack of fertilizer. As a consequence yields are low and production costs are high.

The profitability could increase if farmers are able to produce during the main season and during off season. The crop to be grown should be rice during the main season and vegetables during the off season.

The following table gives actual farmers' rice production budget on a hectare basis.

**Table 4: Rice crop budget**

**Table 5: Rice production cost per hectare in the project zone**

| Item | Unit | Unit cost CFA | Quantity | Amount CFA |
|---|---|---|---|---|
| **Input cost** | | | | |
| Urea | Kg | 250 | 60 | 15000 |
| DAP | Kg | 300 | 20 | 6000 |
| Seed | Kg | 300 | 72 | 21600 |
| Transport | Kg | 10 | 152 | 1520 |
| **GMP functioning** | | | | 0 |
| Gas | l/ha | 585 | 300 | 175500 |
| Oil | l/ha | 2000 | 50 | 100000 |
| **Farm operating costs** | | | | |
| Labour | CFA/ha | | | 20000 |
| Hersage | CFA/ha | | | 7500 |
| Canal maintenance | CFA/ha | | | 7500 |
| Seed bed | Hj | 1000 | 10 | 10000 |
| Planting | Hj | 1000 | 30 | 30000 |
| Weeding | Hj | 1000 | 30 | 30000 |
| Harvesting | Hj | 1000 | 60 | 60000 |
| Threshing | Hj | 1000 | 30 | 30000 |
| **Total operating cost** | | | | **514620** |
| **Yield** | Kg | | | 3500 |
| **Production value** | CFA | 3500 | 165 | **577500** |
| **Gross Margin** | CFA | | | **62880** |
| **Depreciation** | CFA | | | 30000 |
| **Total cost** | CFA | | | 544620 |
| **Net Revenue** | CFA | | | **32880** |
| **Production cost** | CFA/kg | | | **155.60** |

**Source: Farmer information**

## 1.6 Current household requirements for consumption and how these requirements are met e.g. crops farmed by self, payment in kind for labor.

Households' crop production doesn't cover their food requirements. Household consumption requirement in the area is as follow: 65 % millet, 44 % sorghum, 8 % maize and 68 % rice. They produce 60 % of their needs in rice and a very few portion of the crops, the gap is completed from buying with others. However, some villages grow millet, sorghum essentially even though this not enough to cover their needs. After harvest all the youth migrates to other places in the country or out of the country to sell their forces for generating incomes to support their families. The following table gives the time length coverage by their crop productions.

**Table 6: Rate of households' food requirement satisfaction by their own production**

| Periods / Villages / fractions | 1 to 3 months | 4 to 7 months | 8 to 9 months | Observations |
|---|---|---|---|---|
| Iloa | 78 % | 20 % | 2 % | |
| Ikounadène | 100 % | 0 % | 0 % | |
| Dag-Allal | 93 % | 5 % | 2 % | |
| Issafaye-Douékiré | 100 % | 0 % | 0 % | |
| Hondoubomo | | 100 % | 0 % | |
| Dag-Hamzane | 100 % | 0 % | 0 % | |
| Dag-Bohdel | 100 % | 0 % | 0 % | |
| Dag Ibni | 100 % | 0 % | 0 % | |
| Djéguéla | 100 % | | 0 % | 3 to 4 months after harvest |
| Issafaye-Dongaye | 100 % | 0 % | 0 % | 1 month only after harvest |
| Telemedes-Inkarane | 100 % | 0 % | 0 % | |
| Dag Abazanga 1 | 100 % | 0 % | 0 % | |
| Dag Abazabga 2 | 100 % | 0 % | 0 % | |
| Toya | 100 % | 0 % | 0 % | |
| Telemedes 1 | 100 % | 0 % | 0 % | |
| Telemedes 2 | 100 % | 0 % | 0 % | Only 1 month after harvest |
| Tassakane | 40 % | 50 % | 10 % | |
| Taglift-Inkarane | 100 % | 0 % | 0 % | |
| Koulatane-Haoussa | 70 % | 20 % | 10 % | |
| Kel-Tinagueblhadj | 100 % | 0 % | 0 % | Only 1 month after harvest |
| Tin-Telout | | 100 % | 0 % | 4 months after harvest |

**Source:**

Within the commune only 10 % of households at Tassakane and Koulatane Haoussa live on their own production during 8 to 9 months after harvest, while 50 % to 100 % of households in three villages (Tin Telout, Tassakane and Hondoubomo) meet their food requirements in a range of 4 to 7 months during a year. In all other villages households meet their food requirements from their own production during only 1 to 3 months. Globally, within the commune only 4 villages out of 21 cover part of their food needs during 8 to 9 months after harvest. Among these 4 villages Iloa and Dag Allal satisfy only 2 % of their food requirement during a time frame of 9 months after harvest.

From the 8th month after harvest most of households in the 17 remaining villages are dependant on other sources to satisfy their food requirement. In 70 % of villages any household meets its' food requirement after the 3rd month from harvest.

# 2. Inputs/resources

## 2.1 Human resources

### 2.1.1. On and off season labor

On season labor force is available in households and most work is done by all household members. During that time most of people who migrate from the area return back to their household for farm works. Also, at that time families help each other to accomplish certain hard works. Most of group works such as canal building, school construction, etc. are executed.

During the off season many people migrate from the area and labor becomes scarce and need to be hired by households to accomplish activities (farm and non farm). The absence of laborforce during the off season makes some activities difficult to achieve. This explains in part why farmers don't crop their fields during the off season.

## 2.2 Natural

### 2.2.1 Water availability

The main water sources are the Niger River and its' dependant the "Tassakane". Water is available in abundance from July to February in all the cluster area, but from Marsh to June it becomes little in the Niger River and dry in the "Tassakane". During that period water recesses in the Niger River and its' usage for rice irrigation costs more. At that period other crops which don't require a lot of water could be grown in PIVs.

Ground water is not used for agricultural purposes (except for garden crops) in the cluster zone because wells are very deep and fetching water from them for irrigation is expensive and cumbersome.

### 2.2.2 Land availability

Total irrigation area according to the topo survey team is estimated at 8489 ha. This includes PIVs, plains and low land valleys. Not all the land area is suitable for agriculture. The area suited for PIV is 1313 ha. The topo survey team studied in detailed 12 PIVs with a total area of 428.50 ha already built. This area could be extended to 497 ha (an increase of 116.94 ha). According to the survey, extension is possible only on 5 PIVs among the 12.

PIVs in the cluster zone, their present area and their potential area for extension are mentioned in the table below.

**Table 7: Sites and their areas**

| **Circle** | **Commune** | **Village** | **Site** | **Existing PIV area** (ha) | **Extension area** (ha) |
|---|---|---|---|---|---|
| Tombouctou | Alafia | Iloa | Far far | 40 | 26 |
| | | | Dale Téhéré | 33,69 | 0 |
| | | | Saragna | 9,56 | 0 |
| | | | Abatoubangou | 6 | 8,32 |
| | | **Tassakane** | Sororia | 40 | 65 |
| | | | Bandoubanda | 34 | 0 |
| | | **Toya** | Bafundou | 106 | 0 |
| | | **Issafèye Dongoy** | Lafia | 20 | 3 |
| | | | Bangoubando | 20 | |
| | | **Isssafèye Douétiéré** | Darey | 50 | |
| | | **Djeguélia I** | Kandjigua | 55,25 | 14,62 |
| | | **Djeguélia II** | Hondo Tchabya | 14 | |

**Source: Topo survey 2008**

This area is only 37 % of the potential PIV area in the zone. There are large possibilities of building new PIVs in the cluster.

## 2.3 Financial

Farmers in the area are generally poor, they don't have enough resources to pay for the quantity and the quality of input they need. In the area, banks and micro finance institutions are available. Many farmers and farmer associations can not have access to services of these institutions because they haven't reimbursed former credits they contracted.
Causes for non reimbursement are:

- low production capacity;
- willingness to refuse payment;
- lack of sufficient information;
- Illiteracy.

Also for religious purposes many farmers and farmer associations are not willing to engage in a credit system where they have to pay interest rate. Some times even if farmers are willing to engage in bank credit, they are blocked by requirements (guaranties).

Farmers refer very often to the informal credit system because they reimburse in kind. The exchange rate is fixed before harvest and this becomes highly expensive for farmers. This later system doesn't offer a large amount of money to achieve relevant investments.

## 2.4 Organizational

The social organization in villages and fractions within the commune is based on the family. Former large families no longer exist and decisions are made at small family level by its' chief.

At the village level decisions are made both by traditional and modern powers. Two rules govern the social organization: respect for the elderly and respect for the clan. These rules are completed by Islamic rules which recognize Imams.

On the other hand, there are traditional associations in each village or fraction called « Kondeyes » regrouping male and female of different age groups. All collective activities are realized by the Kondeyes.

There are about 64 groups and associations in the cluster of Toya, 37 % of them are in the village of Toya alone. Tassakane and Illoa, the next two largest villages, have 20 % and 16 % of the total respectively. About half of the total 64 (47 %), are farmer-based groups or associations. Most of these groups were formed by previous development projects to support project implementation.

**Table 8: Groups and Associations in the Toya cluster**

| Village | Percentage of Total | Agriculture & Horticulture (as Percentage of Total) | Livestock & Fisheries (as Percentage of Total) | Other (as Percentage of Total) |
|---|---|---|---|---|
| D'Ag Alal | 3 % | 3 % | 0 % | 0 % |
| Djeguelia | 10 % | 5 % | 2 % | 3 % |
| Illoa | 16 % | 5 % | 2 % | 9 % |
| Issafaye Donghoi | 6 % | 3 % | 0 % | 2 % |
| Issafaye Douekire | 8 % | 6 % | 2 % | 0 % |
| Tassakane | 20 % | 5 % | 2 % | 13 % |
| Toya | 37 % | 21 % | 2 % | 14 % |
| Total Number | 87 | 41 | 10 | 36 |

**Source: Rafael Flore and A. Niang 2008**

Gardening and horticulture farmer-based groups are mainly composed of women. While these organizations have been classified as mainly agricultural-based, it is important to point out that they perform other economic activities such as petty trade of different commodities, micro-finance, savings and loans, and, in some instances, small scale milling and processing. All these groups are formally registered and were initiated by previous development projects.

There are associations which are meant for women and have activities like: vegetable gardening, small scale trade, food processing, and collective farm woks (planting, weeding, harvesting), etc. Income generated through these activities is used for social issues (mutual assistance). The associations often don't have formal status and their management becomes very difficult.

Among farmer-based groups, 75 % (of the total 51) are formally registered, 10 % are informal and the remaining 15 % is "unknown" (Table 9). As part of the formal registration process, most groups went through a formation process and several trainings on accountability, management and governance. However, capacity of these institutions is still extremely weak.

There are cooperative, associations organized around communal infrastructures management, such as health, education, bore hoses for drinking water, etc. But their leaders are not always trained and are not able to solve problems faced by the organization.

# 3. Proposed Strategy, Options and Interventions

Farming systems in the cluster are diverse. Farmers tried to adapt to rainfall hazards by incorporating new crops varieties, agricultural practices and rotations to reduce risks for food supply. The production system is based mainly on rice and vegetables for subsistence; nomadic livestock herding and small scale trading. Households own some productive assets (mainly land and limited equipment) which are not sufficient, by themselves, to get all advantages from investments made by the Government and donors in irrigation. While irrigation infrastructure exists, family labor, equipment, savings and financial capital for agriculture are one of the major constrains. Subsistence farming and failed past experiences of former projects, individual households hesitate to invest in innovation to avoid additional risks. Farmers are reluctant to make decisions in investing in new technologies and new management techniques designed to improve their systems.

In the cluster area, many organizations have already benefited from investments made in irrigation. But the major constraint remains on how farmers can crop at least twice per year. In table above, near 70 % of households face food insecurity after three months from harvest. For farmers to fully benefit from investments in irrigation infrastructure, they need to change their management techniques. Any supporting institution should put emphasis in getting farmers further organized and strengthening existing farmers' organizations and cooperatives in the area for a success.

Even though irrigation infrastructures exist, they need to be rehabilitated; issues associated with pump maintenance, PIV management, payment for services and credit should be addressed. In addition, farmers should access improved seeds, fertilizers, extension services, and financial services to become more competitive.

Once these above constraints are alleviated, support to organizations to make market oriented investments and incentives to change the economics should be the main focus. Therefore, for this strategy to succeed, farmer organizations and local community based government must be considered partners and be part in setting projects' intervention strategies.

For the community to start jumping from poverty, emphasis should be put on irrigation first. Developing this sector will enhance economic growth in the area and generate enough resources to provide additional support to other sectors.

## 3.1 Proposed interventions: land allocation, crop rotation and crop intensity

The options to be discussed should include not only crops that are currently cultivated in the area (rice, millet, wheat, potatoes, tomatoes, onions etc.) but the potential for tree crops and other high-value crops (such as cumin)

### 3.1.1 Detailed description of each Options: 1, 2, 3 and any other

The production options are proposed around rice cropping. Double cropping or even triple cropping should be the basic condition. Considering all water and animal husbandry constraints faced in the area, the cold period from October to January must be put to use. Anticipated seedbeds installation must be associated with the use of 120 days varieties so that rice fields could be released in September.

As discussed with farmers and their organizations in the cluster area the following options are proposed.

**1 Optimistic: Agro pastoral spaces protected**

- A1 Rice- A2 Wheat - A3 Rice
- A1 Rice - A2 Garden crops - A3 Rice:

**2 Pessimist: Weak management of agro pastoral spaces**

- A1 Rice - A2 Garden crops
- A1 Rice - A2 wheat

### 3.1.2 Pros and cons of each option

Following our discussions with farmers and farmers' organizations in all villages in the cluster area, they adhere at the above two options. We found that the main constraint in growing crops at least twice in a year is animal wandering during off-season period. Animals and crops belong to the same population. Animals don't have enough fodder to graze in off-season and the only space left with little grass is the PIV area, therefore it is difficult for people to crop during that time. But some villages (Iloa) have enough land; they could chose places where to grow at least two seasons during the year.

### 3.1.3 Competitors and comparative advantages

In the commune there are many projects which fund actions concerning rice production and other development activities. Among projects there are, IICM, MaliNord, PNIR, PIDRN, etc. funded by donors such as USAID, GTZ, World Bank and IFAD.

These donors have different approaches in their funding systems. IICM requests 50 % participation from farmers in all activities; MaliNord requests up to 20 % in canal system building and 30 % participation in buying Motor pumps; PNIR provides the irrigation scheme, the lined main and secondary canals to beneficiaries and farmers have to participate for building tertiary canal and leveling their fields (this is estimated at 20 % of total cost) and PIDRN has a similar system as PNIR.

For the different systems to succeed, projects provide extension assistance to involved farmers and help them access to inputs such as improved seed and fertilizer. They help them access to credit to store their production and sell it later with higher prices.

### 3.1.4 Overall production costs

The production includes labor, fertilizer, pesticide, seed, and water costs. The overall production cost is estimated at 665942500 CFA for option 1a, 1785437500 CFA for option 1b, 1399632000 CFA for option 2a and 9211063000 CFA for option 2b. The labor cost includes equipment depreciation cost; and the water cost includes pump functioning, pump and infrastructure maintenance costs and pump depreciation cost.

Considering all above figures, the most cost effective option is 1a. This could be explained by the cropping intensity and the crop requirements.

### 3.1.5 Overall level of investment including capital costs for the 3 options

To compute the overall investment costs the following items have been considered:

- total rehabilitation cost for 497 ha: for this item we considered overall investment cost minus farmers' participation cost. (546 075 716 – 222 901 875 = 323 173 841 CFA).
- total new PIV building cost for 816 ha: this is the amount of money the topo survey have computed. (822 360 000 CFA)

- crop production costs: it is assumed that farmers will provide labor and pay water fees from their production. Items considered are only input costs. These costs will vary depending on the cropping option. For:
  1a = 324642500 CFA ;
  1b = 309887500 CFA
  2a = 633750000 CFA
  2b = 39890500 CFA
- equipment cost = 218 560 000 CFA

Total investment cost for option 1a = 1 688 733 34 1 CFA; for option 1b the cost is = 1 673 981 841 CFA for option 2a = 1 997 843 841 CFA; and for option 2b the cost is = 1 763 004 341 CFA.

### 3.1.6 Price trend analysis

Prices are very unstable during the year. This can be explained by many factors, but the main ones are:
- production is hazardous,
- farmers are not very well organized,
- they lack storage capacity,
- they don't have access to credit.

Usually prices are low during harvest and high during the rainy season.

### 3.1.7 Overall profitability of the options

The overall profitability by option is computed considering production costs, annual depreciation costs of infrastructure and equipment minus total return from production. The following table gives the profitability for each option

| Options | Production cost | Infrastructure and equipment depreciation | Total option returns | Profitability |
|---|---|---|---|---|
| 1a | 665942500 | 217370682 | 860257500 | 642886818 |
| 1b | 1785437500 | 217370682 | 2080762500 | 77954318 |
| 2a | 1399632000 | 217370682 | 3644368000 | 2027365318 |
| 2b | 921063000 | 217370682 | 1574937000 | 436503318 |

## 3.2 Potential new high value crops that are not currently cultivated in the area

There are several high value crops which are not cultivated by farmers in the cluster area. Among these we have Anis, Cumin, Wheat, Potatoes, etc.

## 3.3 Ability and desire of farmers to adopt these systems

Farmers in the area have knowledge of growing these crops. For Anis and cumin production, farmers don't do it because: first, their objective is to insure food security; second, water is not available at the suited time; third, they don't have access to the market. For wheat production farmers usually have rice in their field when wheat needs to be planted, therefore the time conflict between these two crops prevent them planting wheat which is considered secondary to rice for the yield and food habits. For potatoes production, farmers don't have access to seed and fertilizer in the area, but are willing to cultivate potatoes.

## 3.4 Government potential support and overall interest

The government is interested in supporting farmers diversifying their production to avoid climatic hazards and to make more returns from their activity. For this purpose the government funds projects in the area to help improving incomes in the area.

# 4. Value Chain Detailed Analysis

## 4.1 Inputs

### 4.1.1 Package of inputs required

Inputs requirements are determined from optimal amounts advised by the research and extension services. For mineral fertilizer the advised quantity is 200 kg/ha of urea and 100 kg/ha of DAP. The amount of improved seed needed for a hectare is 50 kg. According to options, the area and the amount of inputs needed are indicated in the excel spread sheet file.

### 4.1.2 Fertilizers, seeds and agro-chemicals: sourcing, transportation, costs, etc.

Farmers can access seed from the national seed company (SSN) or from research or from NGOs or from individual producers called seed farmers. The best bet is to get seed from seed farmers in the area to avoid transaction costs. If those farmers don't exist the project should train farmers for the purpose.

Fertilizers are not accessible on the near markets, if they are the cost is very high, therefore not financially affordable by farmers. Village input shops should be built and furnished by the help of the project to allow farmers to access fertilizer depending on their financial capacity. In the area there are no fertilizer suppliers, but some traders sell small amounts timely.

### 4.1.3 Irrigation

#### *4.1.3.1 Rehabilitation of existing structures*

The rehabilitation will carry on the repair of canals with option of lining the main canal which reduces water loss, allow setting up a good water schedule; this will result at a 20 to 30 % reduction of gas consumption. According to the topo survey PIVs will be rehabilitated and extended, this is cheaper than building new perimeters. Rehabilitation cost is estimated at 1 099 828 CFA/ha on average.

#### *4.1.3.2 Construction of new ones*

New PIV construction cost in the area is estimated by the topo survey team at 1007795 CFA/ha with population participation (see topo survey team).

#### *4.1.3.3 Proposed irrigation scheme (topo survey team)*

The irrigation scheme should not be lower than 25 ha. This, because PIVs main objective, farmers working capacity and land productivity. Small size perimeters don't have a good organization and are generally owned by a household or an individual. Bigger size perimeters are difficult to manage such the case in Toya with 105 ha. They require many pumps, therefore high expenses that farmers could not support due to their poverty status and their lack to access credit. There are many perimeters with 40, 45, etc. ha which function correctly in the area. Therefore the manageable scheme could range between 25 and 50 ha.

### 4.1.4 Labor: for what agronomic activities, costs, etc. assumptions on which this is based

Rice cultivation is highly labor intensive. The number of days of labor can reach up to 150 man days per hectare. To transplant seedling and control weeds alone requires 70 man days of labor per hectare. In some villages landless or marginal farmers are many and constitute up to one third of households. Labor accounts for 37 to 40 % of the total costs of the farmer. Most of it is non cash and is delivered by the farmers' family.

### 4.1.5 Mechanization: sourcing, costs, specifications, etc. Ways in which labour requirements can be reduced

Groups have a few productive assets including sows, oxen, animal traction for land preparation, hoes, water tanks, motor pumps, etc. Farmers lack several important equipments which could be used collectively if they are more organized. Such equipments are rice milling machines, threshing machine, etc.

At this stage it is difficult for farmers to access individually machines, but with the development of production and productivity, they will increase their incomes and be able to purchase equipments, by accessing credit or other sources.

With these machines farmers will be capable of threshing their paddy at low costs.

## 4.2 Best Agronomic Practices for the package

### 4.2.1 Best package of inputs for each option: seed varieties, input rates, agro-chemical requirements; main diseases, etc.

The best agronomic practices for different crops are given in annex

### 4.2.2 Temperature tolerances for the crop and how this fits in with the annual temperature cycle

### 4.2.3 Growing cycle and agronomic calendar for the crop: this includes duration, main agronomic tasks, etc.

Rice is produced during the season from July to October and also but in a smaller volume at off season (Marsh to July) because of water recession. In the area there are many PIV within a village; some are used in season and others for the off season. Rice is the major staple food in the commune; substitutes are wheat, millet or sorghum. However, production of all crops is not sufficient to cover population needs, there is a large gap between quantity produced and quantity needed.

### 4.2.4 Crop rotation and intercropping

In the PIV area farmers don't practice intercropping and rotation. However, the plant some crops on the edges of their plots. These crops are not for sale purposes, they are used for household consumption. Farmers don't practice any improved technologies on these crops.

### 4.2.5 Water requirements for crop rotation, irrigation system recommended and type of pumps and fuel will be required to achieve this on a per hectare basis.

Based on water constraints stated above, crop rotation should follow options described in the text. The type of pump should be chosen in accordance with farmers or farmers' organizations, because they have a great experience in using pumps and are familiar with the kind of problems they will face. However, it is useful to advise farmers on the type of fuel, where to get the fuel and how they should keep it.

### 4.2.6 What is the optimum pump placement of these pumps to reduce the cost and achieve the maximum impact? (topo survey team)

### 4.2.7 Labor costs in planting and growing the crop.

The following crop budget gives rice production costs on a hectare basis in present situation.

From the table, labor cost represents 31 % of total production cost. This, because rice production activities in the area are manual (farmers lack equipment). Labor takes more than 1/3 of production cost; this means any development strategy regarding the rice should put emphasis on alleviating manual works in the area.

## 4.3 Harvesting

### 4.3.1 Discuss the issues involved in harvesting the crop

Harvest has a social character in the zone and makes production estimation difficult because workers are paid in kind (paddy). This payment is not counted by farmers when they declare their production.

### 4.3.2 The amount of labor that will be required?

For harvesting the amount of labor needed is about 60 man/days per hectare. This amount is not usually available in households, to satisfy at it farmers will hire temporary labor or use village aid groups. The equivalent money is evaluated at 60 000 CFA assuming that a man/day costs 1000 CFA.

### 4.3.3 Will any machinery be needed? If so, specifications, sourcing and costs of machinery

The harvest is done by workers and since the areas allocated to individual farmers are not big enough, any machinery is not required to do so. Harvest is considered as social event in the villages, doing it by machinery will modify part of their life style.

### 4.3.4 Can the costs be optimized with the introduction of machinery?

It is not economically profitable to use machinery for harvesting because as said above, plots are small not only for individual farmers but also for the whole PIV. For machinery to be economically profitable; individual plots should be bigger and the machine should be able to work on several PIVs.

Machines such as threshers could be used on big PIVs or for several PIVs; but it should be managed by an independent committee. This committees' mandate will be to make the action profitable.

### 4.3.5 Post-harvest management

In general rice is sold at farmers level in paddy form, then de-husked by hand pounding or in small milling machines for end trading. Any further refinement such as parboiling, polishing and packing takes place in other places. It is quite common for the trader to do the milling and bagging of rice. Producers' competitiveness is affected by numerous factors, such as processing and storage. It is important to help farmers having their own rice mill to prevent millers; wholesalers and retailers getting their part of benefit in the chain.

## 4.4 Storage

All communities have grain storage facilities available. These facilities are legacy of previous development projects in the area. Currently there is no surplus of grain and therefore storage facilities are empty. No fee is charged if farming households decide to store any surplus in these facilities.

### 4.4.1 How will the crop be stored once it is harvested?

Rice will be stored in common storehouses built by the communities for quantities collected for water fees and credit reimbursement in different villages within the cluster. Concerning individual farmers, they will store their crops in personal granaries, if there is excess production.

Production will be stored in paddy rice form sorted in 100 kg bags. Storage quantities will vary depending on sizes and productivity. There is no storage system built for vegetable conservation in the area, but farmers use traditional storage system which consists of drying the crop before putting it in safe places.

### 4.4.2 What are the risks to storage?

Paddy rice could be stored for a relatively long time if facilities exist. This is true for the other cereals (wheat, millet, sorghum and maize). Risks associated with storage are enormous in the area.

Houses built for the purpose are in earth and subject to risks of sweating when it rains or collapsing. Farmers don't treat their stock before storing it, therefore it becomes subject to attacks of insects and rats. Also, farmers are not trained for drying the paddy once it is harvested before they store it; this makes the paddy subject to mold. Long time storage of paddy doesn't benefit sellers (farmers or farmer associations) because it looses weight.

For other crops risks exist because of the lack of infrastructures meant for the purpose. It is practically at the present stage to store vegetable crops such as shallot/onion, potatoes. Storehouses for these crops should be built in different villages to help farmers capturing the benefit of increased prices.

### 4.4.3 Cost of storage structures?

There are in the area villages which built their storage house from proper funds or from support of donors. In Toya they built two warehouses which cost about 2 000 000 CFA each with a total capacity more than 500 tons.

Usually individual farmers don't store their productions in these storehouses, they are meant for the group. As stated above these storehouses serve to keep water fees and reimbursements in kind.

Farmers have their traditional storage practice, but they are not efficient for large quantities. In the area farmers store mostly their produces for consumption purposes. Only excess production is sold to the market and this quantity is generally small because productivity and total production are weak.

Small traders use stores in villages to keep their selling products; in these stores (very small capacity), they pay 100 CFA/bag per month. This practice is not based on any economic consideration.

### 4.4.4 Any existing structures or all will have to be built?

In all villages in the cluster, since they got assistance from other project in the past, there is at least one storehouse. The purpose of the storehouses was explained earlier in the text (to keep water fees, credit reimbursement in kind or store fertilizer and other inputs). These storehouses are not maintained correctly and therefore are in degradation. They need rehabilitation in villages where they exist and new construction where they are completely degraded or don't exist.

The aim of the project is to increase production and to add value on products, therefore at least in each an appropriate storehouse should exist.

### 4.4.5 For how long different crops could be stored, what measures need to be taken and what equipment is needed

Cereal crops could be stored for 3 to 6 months in the facilities without any processing according to farmers. But for vegetable crops a drying system should be in place before their storage. Cooling system infrastructures are not available in the area and their construction will cost enormously expensive. There is no vegetable processing plant in the area where farmers sell directly their production.

Dryers should be purchased for vegetable crops conservation (onion, tomatoes, okra, etc.); but for potatoes

### 4.4.6 What is the overall storage capacity needed and where can it be located

A discussion with farmers, the potential crop area and the payment of corresponding water fees (800 kg of paddy/ha) show that the overall capacity could be about 2000 tons in the area. It can be located at Toya according to the mayor of the commune and the technical services, because its' access is easier for vehicles and boats.

## 4.5 Agro-processing

### 4.5.1 Any agro-processing required to increase benefit

Most of the rice produced on different PIVs is sold in paddy form. The paddy could be milled and sold. This latter form has a great value added to the price. Paddy rice could also be parboiled before being milled. Parboiled rice is used by people who have diseases such diabetes. Rice by-products are used for animal feed (farmers don't benefit it because their rice is milled elsewhere).

### 4.5.2 Machinery requirements: costs, source, technical specifications, etc.

Local traders, who generally provide also transport to collect the paddy, play an important role in paddy trading through channels. Generally the rice is de-husked in village small rice mills or by hand. Any other refinement such as parboiling polishing, packing, etc. takes place in other places. Even if farmers realize that bigger benefits from rice production go to millers, wholesalers and retailers in the chain, they have not developed any action to purchase collectively milling machines.

The farm equipment requirement is based on cultivated rice area, machines capacity and crop cycle during the main season. The equipment park is constituted for each village of the cluster based on irrigated land area and will have: land preparation equipments, harvest and post harvest equipments. The following table gives the number for each equipment per village.

**Table 9: Requirements out of agricultural equipment by village**

| Villages | Surface ha | Threshing-machine | Millers | Cultivator: plough to puddle, cart |
|---|---|---|---|---|
| Iloa | 240 | 6 | 1 | 6 |
| Djéguelia | 70 | 2 | 1 | 2 |
| Toya | 200 | 6 | 1 | 6 |
| Tassakane | 300 | 6 | 1 | 6 |
| Issafaye Dongoye | 140 | 4 | 1 | 4 |
| Issafaye Douekiré | 140 | 4 | 1 | 4 |
| Dag-Alal | 150 | 4 | 1 | 4 |
| Total | 1240 | 32 | 7 | 32 |

The total equipment requirement are estimated at 32 cultivators, (a cultivator is equipped with plough, peddler a leveler and a cart), 32 threshing-machines and 7 milling machines. This option of small motorization will require in the area the creation of new jobs such as drivers, repairers and suppliers of spare parts.

**Table 10 : The following table gives the unit cost of each type of equipment.**

| Item | Unit price in CFA |
|---|---|
| Cultivator | 3000000 |
| Plough | 85000 |
| Herse | 60000 |
| Puddler | 60000 |
| Thresher | 2750000 |
| Miller | 4000000 |

## 4.6 Transportation

There are several roads and tracks in the region of 1157,4 km among which 17,7 km are with asphalt road, 131 km are improved road, 1008,7 km are seasonal tracks. In the commune the main transportation routes are the Niger River linking the commune to Mopti, Tonka, Diré, Bourem-Inaly and

Gao and the road linking the commune to principal trade centers: Timbuctu, Douentza, Gao, Diré, Léré, Niafunké, Tonka and Mopti.

The practicability of the main axes is officially possible all year long since the building of the roads Tombouctou-Douentza and Tombouctou-Goundam-Diré-Tonka; but by the river, transport depends on flood regimes (usually from July to December).

The practicability all year long of the roads depends on the type of vehicle, because during the rainy season only 4x4 vehicles can ride correctly. Trucks and buses could make several long hours between localities.

### 4.6.1 How will the harvest be transported out of the cluster and to the determined markets?

The harvest could be transported by road in trucks or by the river in boats (pirogues) depending on the season. Transport is a major problem in the area especially during rainy season. The road system is rough and request long time waiting to cross the river. Transportation cost is also high with risks of breakdowns and not reaching destination at time. The remaining possibility is boat (fluvial). This last opportunity is slow and associated with many risks.

Access between villages/fractions of the commune remains also a problem. During flood period, some localities are accessible only by using the river (boats, pirogue).

Even though localities seem close to each other regarding distances, villages/fraction connexion among them is a constraint having effects on the amount of time spent during population travelling for health care, school and administration.

### 4.6.2 What is the most cost effective method – road or river?

Transport cost issue should be considered taking into account the money disbursed and the time frame for journey. There are two main seasons for transportation: the dry season when vehicles are used and the wet season when River transportation and road transportation are done simultaneously. During dry season produces can reach the commune the same day from Mopti or Gao regions, but because of the bad road transportation fees cost high (2000 CFA to 3000 CFA/bag). Risks associated are in case of breakdowns several days will be needed to fix the failure; because mechanics are not available in the nearby. During the rainy season transport

is done by road (transport of persons) and by river. River transportation is not expensive (1000 CFA to 1500 CFA/bag) but it is associated with risks of boat sink, humidity and time consuming.

Regarding cost (financial) the river transportation is most effective, while when associated with all risks, road transportation is most cost effective.

### 4.6.3 To which places will we transport the produce and at what cost?

Produce can be transported within the commune and other localities in the region and to other regions such as Mopti and Gao in the country. Produce can also be transported to other countries such as Burkina Faso and Niger. All crops grown can be transported to localities in the country, but to another country, main crops are shallot (onions) to Burkina Faso and anis and cumin to Niger.

Transportation costs will vary depending on the season and the transportation method. From Mopti to Timbuctu or vise versa, transportation cost for a bag of 1000 kg is 1500 CFA by boat and 2000 CFA by road. Within the region the cost per bag is 500 CFA by boat and 750 CFA by truck.

### 4.6.4 Will we need to own the vehicles or can they rented?

Vehicles are available in the project area for transportation; it is probably more profitable to rent vehicles for products or input transportation than owning them. In the area many services and projects have small boat or cars for staff traveling from village to village, but for transporting loads they hire vehicles from private individuals or use the boat company.

## 4.7 Markets

### 4.7.1 Identify the key markets for this product

Customers are population in the commune, population of Timbuctu town and population from other communes within the region and other regions (Gao, Mopti). The population of the region and the other regions is increasing according to demographic trends in the country. The number of persons living in towns is also increasing. This will end by a smaller number of producers and a larger number of consumers.

For rice production the markets are localities within the region and the regions of Mopti and Gao. For shallot (onions) markets are Mopti city and

Bobo Djoulasso in Burkina Faso. Concerning anis and cumin markets are Niamey in Niger and eventually Lome in Toge or Accra in Ghana.

Farmers have explored most of these markets with other projects in the past, but they are not organized and trained to satisfy requirements on these markets. For anis and cumin which are very high value crops, their production are time consuming and the yields are low (grains are very small and fin). According to farmers they sell at low price their product in Niamey because they don't have information on the market before they leave their localities. Discussions with other projects members proved that produce from Mali are used and packed for sale at very high prices with other labels in Accra or Lomé.

For shallot, project explored the feasibility of selling at Bobo Djoulasso market and found it highly profitable. For shallot marketing, the following transportation system was imagined: boat transportation to Mopti and truck transportation from Mopti to Bobo.

### 4.7.2 Location, distance, access, transportation risks, etc.

Major markets for rice are Timbuctu, Hondoubomo, Gao, Mopti. Distances form production areas to markets are not far for those which are in the region but far those external to the region. The road system is very bad, especially during rainy season. From July to December transportation is done by boats on the Niger River. This mean of transportation costs less but is more risky. For some vegetable crops (tomatoes, fresh okra, lettuce) it is not appropriate to travel by boat (the boat is very slow).

From Toya, the commune headquarter and nearby villages
South Toya- Tiborahane (commune de Haribomo) : 50 km of seasonal track
East Toya-Hondoubomo Ababer (commune de Bourem inaly) : 35 km of track
South Toya- Aglal (commune de Lafia) : 45 km of seasonal track
North Toya-Agouni (commune de Salam) : 60 km bad permanent track
West Toya-Douékiré Essakane village (commune de Douékiré Essakane) : 45 km of bad track
North Toya – Agouni (commune de Salam) : 60 km of bad permanent track
North West Toya – Essakane village (commune de Essakane) : 55 km of bad permanent track
South West Toya – Koira Tawo (commune de Garba Koira) : 25 km of seasonal track

### 4.7.3 Distance to each market?

The main market in the area is Timbuctu, the distance from production sites to this market is around 30 km on average. The longest distance is 40 Km in the cluster and the nearest is 12 km form the market. To attend the production sites one can use vehicles, boats, carts pulled by donkey, etc.

Distance from Toya to main villages/fractions and trade centres

Toya – Tombouctou : 19 km, good road and paved
Toya-Kabara: 11 km paved road
Toya- Hondoubomo: accessible all year long: 15 km
Toya-Tassakane : 7 km good road
Toya-Issafaye : 14 km bad road and fluvial transportation in flood period
Toya – Mopti: 380 km year long with 190 km in earth
Toya- Gao: 400 km all year long

### 4.7.4 Estimated cost to transport to the market?

Transport cost varies between 750 and 1000 CFA a bag of 100 kg by vehicle within the region and 500 to 750 CFA by boat. The transport cost outside of the region varies between 2000 and 3000 CFA depending on seasons. During rainy season population use boat transport to attend markets, while during the off season they use vehicles.

### 4.7.5 Potential risks of transporting to that market?

Risks associated with transport are related to the status of the road (bad road) and the river (boat sink, travel time, etc.).

### 4.7.6 Potential buyers

Producers sell their paddy rice during harvest time at very low prices to consumers in urban and rural areas within or near the cluster zone, local traders and intermediaries. Potential buyers are traders and exporters in the country. According to farmer associations several traders are willing to engage in contract with them if they are able to supply important quantities of rice.

The state trading agency (OPAM) could also be a potential buyer if farmers could build agreement with it. Also, Mauritania's traders could be potential buyer because they neighbor with the region and are importers.

In the area rice is sold small quantities by individual farmers for immediate cash needs. Farmer organizations are not well organized and don't have the required capacity to negotiate with traders. They are not trained to respect engagement in a contract, they can't attract clients.

Farmers sell small quantities on weekly markets in the village or in other villages in the commune. Actors involved in the selling process are producers, intermediaries, transporters, whole sellers. The paddy is processed in Timbuctu or other locations far from where it is produced.

A credit system avoiding farmers to sell at very low prices their product (Warrantee) should be put in place within villages.

### 4.7.7 Based on prices, location, distance and overall transportation costs, identify main potential markets

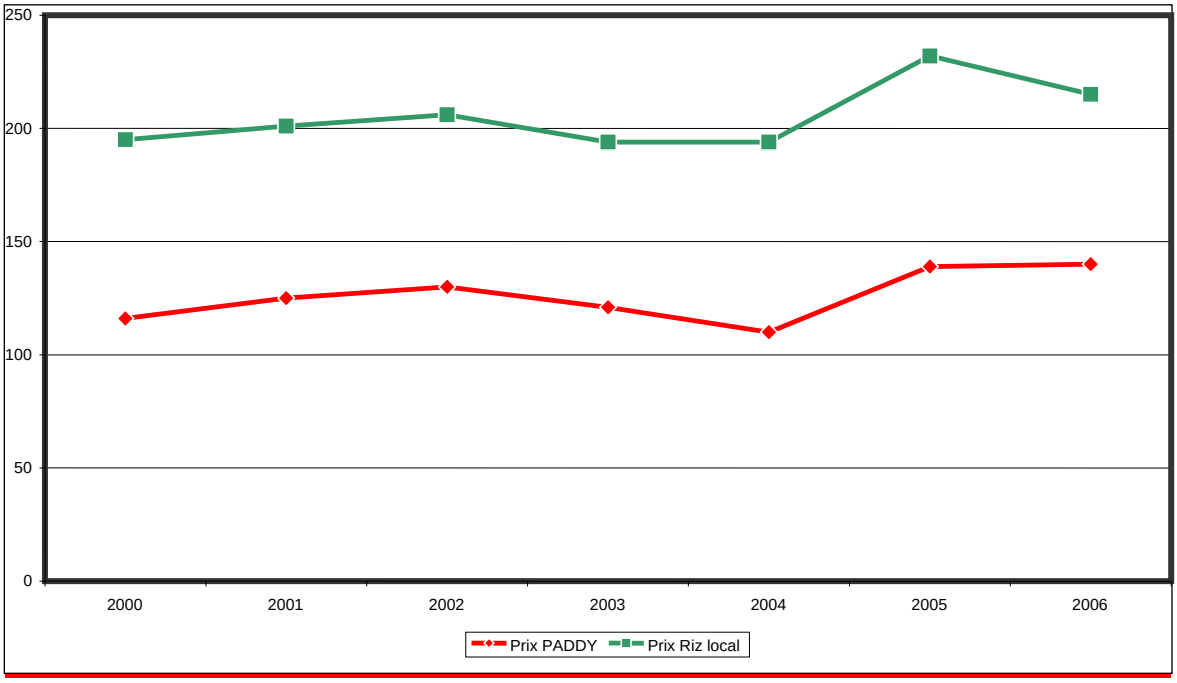
Main potential markets are:
- within the commune: nomadic fractions,
- within the region: Timbuctu city, Hondoubomo, Bourem Inaly, Tonka,
- within the country: Mopti and Gao regions.

## 4.8 Prices trend analysis

### 4.8.1 What kind of price fluctuation do you have for this crop between high and low season?

The price of paddy fluctuates from simple to double between high and low season in the area. The price of a "pot" of paddy in Toya is 175 CFA at harvest time and 350 CFA during rainy season on average. This high fluctuation is due to lack of relevant information of producers and credit system permitting them to store their paddy for a longer period.

**Figure 1: Evolution of rice prices in F CFA / Kg**




### 4.8.2 What are the different prices for each commodity: farm-gate, local markets, regional markets, national markets and international markets

Farmers usually do not sell their produces at farm gate; they sell on markets (commonly on local markets). The following table gives different prices of different commodities on main markets.

**Table 11: Average prices of different crops on different markets (in CFA)**

| Products Markets | Paddy | Rice | Shallot | Potatoes | Tomatoes | Anis | Cumin |
|---|---|---|---|---|---|---|---|
| Hondoubomo | 165 | 350 | 200 | 300 | 150 | 700 | 500 |
| Timbuctu | 165 | 350 | 200 | 300 | 150 | 700 | 500 |
| Mopti | 175 | | 300 | 400 | 200 | 750 | 600 |
| Gao | 175 | | 300 | 400 | 200 | 750 | 600 |
| Bobo | | | 400 | | | | |
| Niamey | | | | | | 1500 | 1000 |

**Source: compilation of reports (2004 to 2007)**

### 4.8.3 What kind of inter-annual variation do you see in prices for these crops?

These crops prices vary considerably during a year. Rice prices vary from simple to more than double over the year; this happens because farmers have to sell their crop at harvest when the supply is greater than demand and buy the crop with traders during the rainy season when they finished their reserves.

For vegetable crops, because of their short trade period, they cost relatively less at harvest period. During the remaining period of the year their costs are high. They are not produced at important quantities due to population consumption habits and the difficulties to store them. Produces such okra, tomatoes, shallot are dried in a traditional manner for conservation.

## 4.9 Supporting services

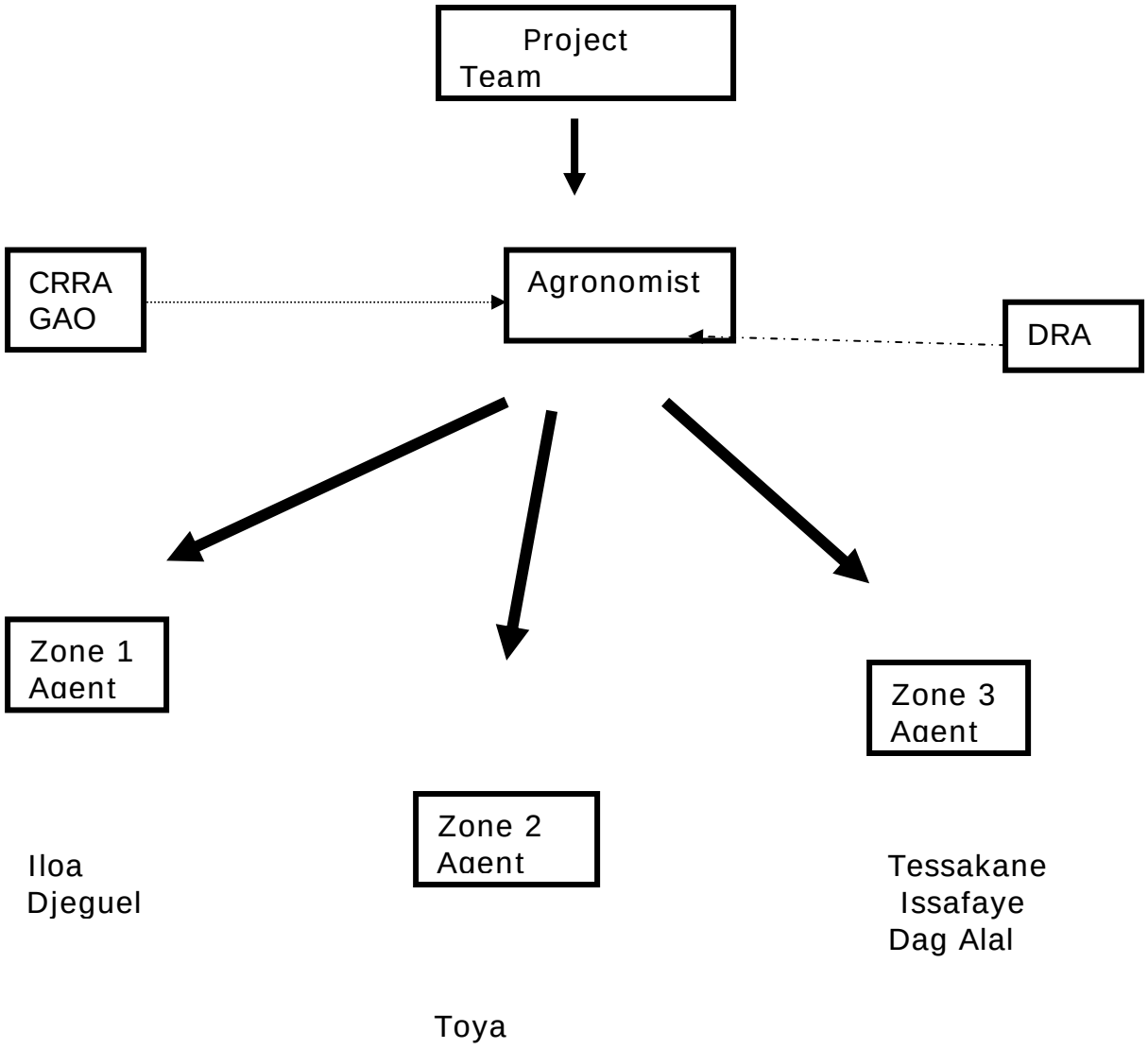
### 4.9.1 Extension services: sourcing, total number, technical expertise, etc.

The current situation shows a weak coverage of the area by extension agents. The program will reinforce extension service by one agent for 2 villages. This presence at the village will be reinforced by a backstopping of DRA (national extension service) staff and project staff.

The extension agent will ensure a correct set up of agricultural schedule and the technical itineraries through participative animation.

The whole staff of the extension will be trained on Integrated Crop Management approach, techniques of learning plots, training and demonstration; in order to be able to use these tools with producers within the Cluster for technologies diffusion. The extension diagram could be summarized as follows.

**Figure 2: Extension flow chart in PIVs**




### 4.9.2 Micro-finance

A Line of micro credit financing will be established within a bank, i.e. the National Bank for Agricultural Development (BNDA) or other banks. It is aimed to support the farm intensification and diversification.

The management and distribution of the proposed line of micro credit financing will be, on contract basis, through existing Decentralized Rural Financing Institutions and NGOs that are already involved in Mutual Credit System, in Village Saving and Credit Associations and jointly liable credit system in the area which are agreed by the Ministry of Finance.

The financial mechanism to put in place aims to develop a sustainable self managed and financed system. Fundamental principle of the approach will be as follow:

- Savings will precede loans
- Financial services (saving and loans) will be decentralized and managed at a village or a group of village level through Village saving association system created for the purpose.
- Village saving association systems should be created following the administrative division (at communal level) and built at the communal headquarter village

Village credit association systems will be put in a network in the long run.

The credit line will be set up to assist intensification and diversification program of agricultural production and also revenue generating activities initiated by women. A memorandum will be signed between the government and BNDA.

The *Projects* plays a preponderant role and an important one in the organization of villages as in the mobilization of savings. The credits are provided based on a line of credit or revolving fund, made available to the Village Associations. The weaknesses of this system: difficult credit management, low recovery rates (beneficiaries often consider the fund as grant), lack of professionalism.

### 4.9.3 Price information systems

The only formal price information system in the area is the OMA “Observatoir du Marché Agricole”. This system provides weekly information on prices and quantities of goods on rural and urban markets. These information are usually not used efficiently by producers and traders.

### 4.9.4 Transportation

There are mainly two transportation seasons: from march to july the principal mean of transportation is vehicle and from july to December boat transportation is the most used. Transportation is done by trucks, buses, cars, etc. Boats and pirogues are also used to transport heavy loads of merchandise. The main port is Koriomé at 17 km from Timbuctu.

### 4.9.5 Government support

The governments' priority is to have full water controlled irrigation agriculture. For this purpose many supports are made by the government through donor funded projects, such supports are: extension services, credit services, facilities to access inputs, etc. In the trade sector the government alleviated taxes on agricultural products and inputs. Taxes waiver are also on agricultural equipments.

The government plays a major role in rice production and marketing. The rice support program introduced last year "rice initiative" by the government provides fertilizer and improved seed for rice production at half to farmers. This program's main objective is to boost rice production and productivity in the country.

### 4.9.6 FBOs

The analysis of the rice market shows that even though the area has become one of the large rice exporters to other regions in the country, this wealth has not been distributed equally between farmers and traders. Analysis of the rice supply chain in the region reveals that the value increases, which double the price once it leaves the farmers' hand, serve to enrich middlemen, millers and traders.

"Farm gate" price of paddy is about 1/3 of milled rice price. Farmers who are mainly subsistence producers acquire on average 165 CFA/kg of paddy, this represents 47 % of the milled rice value. This proportion should increase in favor of farmers.

### 4.9.7 Any other supporting service

There are many supporting services involved in irrigation development in the area: NGOs, projects, national technical services, etc. These services train, inform and sensitize farmers on best production practices mainly.

# 5. Funding Requirements

## 5.1 Total costs

Total costs depend on cropping options; considered cost are those calculated earlier in the total investment section.

## 5.2 Funding options

Funding options are based on the following assumptions:
- equipment and infrastructures have a life span of 10 seasons,
- farmers will reach full yield and management performance at the fourth year of project intervention,
- crops in consideration are the one in the different options,
- Farmers will contribute to investment in PIV building at a rate of 20 %.

Assuming that farmers and the project will respect engagements, the following funding options are proposed:
- *first intervention of the project should be to rehabilitate existing PIVs in the area:* the main canals must be lined and new GMPs bought. These PIV will constitute the first generation of the project, they will receive adequate extension services and organizational training and put in connection with input suppliers, financial institutions and markets (within the country and outside of the country),
- *second intervention should be to construct new PIVs:* they will be the second generation of PIVs in the area. On them the project will consider the production options (during the main season and off-season) and some farmers will be specialized in rice seed production. For market garden crops, producers will be connected to markets and traders,
- *third intervention is to put the different PIV in a network:* during this phase the project will take actions to upgrade farmer organizations horizontally by connecting different cooperatives and vertically by connecting producers, processors and traders.

These three activities should be done simultaneously.

**Cash flow:**
- See annex (Excel file)

# 6. Impact Analysis

## 6.1 Potential impacts of project in the area

Implementation of the project will provide several impacts; the most important ones are:

- Food security
- Income of farmers
- Migration
- Gender equity
- Poverty alleviation.

*Food Security:* the project will enhance crops production in the area, rice yields will increase from 3.5 tons/ha to 6.5 tons /ha. Therefore, for a total cropped rice land of 1300 ha, total production will be 8450 tons of paddy (5492 tons of rice) during main season. With a total population of 5668 inhabitants and rice consumption rate of 68 % of cereals, the production outstands by far the needs. Even with an increasing population, production could support consumption needs.

*Farmers Income:* Since production will satisfy consumption and there will a tradable extra, total in come in the area will be raised. The remaining rice quantity is estimated at 4721152 kg, the value at 300 CFA/kg is 141645600 CFA.

*Reduction in migration:* since with the project intervention there will be two or three cropping seasons, labor force will remain within the area. This will enhance total production and households' income by diversifying production and income sources.

*Gender equity:* the project will develop market garden crops such as potatoes and shallot or tomatoes. Garden crops are usually meant for women in the area. Women will have access to milling machines and others which would reduce their labor time and make them more available for income generating activities.

*Poverty alleviation:* Rise in food security, increased income and gender equity will contribute among others to reduce poverty in the area.

# Conclusions

The study has found the following main conclusions:

There is a big potential for irrigation investment in the area. The estimated area for PIV building is 1300 ha. Farmers have the possibility to grow crops during season and off season, but are limited by the water withdraw in the river and animal grazing. To avoid conflicts between farmers and herders during off season only 50 % of the cropping land could be farmed.

Crop yields and specifically rice yields are low because of lack to access improved seed and fertilizers. Farmers in the area use very little amount of fertilizers, ranging from 0 to 72 kg by plot of 0.25 ha, and government “rice initiative” made certain PIV reached to 76 urea kg/ha. Putting in connexion input suppliers and farmers’ organizations will in a win –win sphere such that there will be group purchasing and group selling.

Farmers in the area are not equipped; they do most of their field work by hand and therefore are not able to farm large fields. Hired labour availability is often a big constraint especially during the off season. The project should help farmers to improve their equipment at household level by accessing individual equipments such as ploughs, carts, etc. and village level equipments such as threshers, millers, etc.

During the main season farmers should be advised to grow rice on their field for food security wise and grow vegetables such as potatoes, tomatoes, shallot/onions, etc. They could grow crops up to three times a year depending on scheduling. Possibilities are: main season, early off season and late off season.

Transport is a huge constraint in the area. Building roads is very expensive, therefore, group purchasing and group selling could alleviate the delivery burden in which farmers and their organizations are. Storage houses with big capacities should be built in different villages to facilitate group actions.

Potential markets exist for different crops within the area and outside the zone. The project should help identifying other actors in the different value chains, putting in relation actors and be a facilitator in the value chain development. For the project to play an important role in the chain development a framework where smallholders will be empowered should be in place before.

Prices are very variable during a year and products are not processed especially vegetables which have a short trade life. And markets exist for processed vegetables outside the country; therefore the project not only should develop vegetable production but also develop processing by training farmers in drying.

Cost/benefit analyses proved the investments in the project very profitable; calculated TIR varies from 25 % to 126 % according to farming options. However, the project is relatively sensitive to crops and yields. Therefore to secure production it is necessary for the project to focus on farmers coaching.

**Annexe1**

## RIZ IRRIGUE

### Préparation du sol

Il est recommandé de bien préparer le sol avant le repiquage. Un labour suivi d'un hersage précède la mise en boue. La traction animale ou la motorisation peuvent être utilisées.

### Pépinière

Pour le repiquage d'un hectare, la pépinière doit être semée dans un basin de 300 à 500 m² à raison de 40 à 60kg/ha de semences suivant les deux techniques connues la pépinière humide ou la pépinière sèche.

La fertilisation minérale de la pépinière est de 10 Kg DAP (phosphate d'ammoniaque) 10kg sulfate de potasse ou chlorure de potasse au semis et 5kg d'urée à la levée. La fumure organique peut être apportée à raison de 500kg.

### Semis

Pour le semis à la volée à sec, la quantité de semences est de 120 kg/ha. Quant au semis à la volée avec des semences pré germées, la quantité est de 80 kg/ha. Les dates de semis optimums se situent entre le 15 juin et le 15 juillet.

### Repiquage

La densité recommandée pour le repiquage est de 20 cm x 20 cm à raison de deux plants/poquet soit 500 000 plants/ha.

### Fertilisation plein champ

La fertilisation minérale recommandée pour le riz irrigué en saison est de : 100Kg DAP, 100Kg de sulfate de potassium en fond et 200 à 250 Kg Urée en 2 ou 3 fractions suivant la maîtrise de l'eau, tallage, initiation paniculaire, montaison.

### Entretien

Le premier désherbage se fait environ 15 jours après le repiquage. Les autres désherbages se font à la demande.

En cas d'attaques généralisées de la panachure jaune du riz (RYMV), l'utilisation des herbicides pour le désherbage est recommandée.

1) **Herbicides recommandés en riziculture au Mali**

| Nom commercial | Matière active en gr/l | Dose en l/ha | Type produit | Epoque d'épandage | Conditions d'application |
|---|---|---|---|---|---|
| Basagran PL2 | Bentazone 160 +Propanil340 | 6 | Sélectif | Post Emergence des adventices et du riz 2-5 feuilles | Adventices au stade plantule |
| Ronstar PL2 | Oxadiazon 80 + Propanil 400 | 6 | Sélectif | Post émergence des adventices et du riz 1-2 feuilles sept à dix JAS | Adventices au stade plantule |
| Ronstar 25 EC | Oxadiazon 250 | 2.5 | Sélectif | Pré émergence | Avant le semis |
| Rilof S 395 | Piperophos 250 + Propanil 250 | 6 | Sélectif | Pré émergence | Adventices au stade plantule |
| Rifit extra 500 EC | Dimétametryne 170 + Pretilachlore 250 | 4 | sélectif | Pré émergence | Adventices au stade plantule |
| Top Star 400 SC | Oxadiargyl | 0.5 | sélectif | Pré émergence | Avant le levée des adventices et du riz |
| Londax 60 DF | Bensulfuron-Methyle 60 % | 80g/ha | sélectif | Post émergence des adventices et du riz, stade 2-3 feuilles et tallage 21 jas | 5-10cm de lame d'eau |
| Garil | Triclopyr Butoxyethyl Ester 72 + Propanil 360 | 5 | sélectif | Post émergence précoce 15-12 JAS | Adventices au stade plantule |
| Roundup | Glypgosate 360 | 8 | Non sélectif | Post émergence des adventices | Riz sauvages en végétation active, bien développés |
| Argus | Sel iso-propylamine de glyghosate 480 | 4 | Non sélectif | Post émergence des adventices | Riz sauvages en végétation active, bien développés |
| Gallant super | Haloxyfop ethoxyethyl | 2 | Non sélectif | Post émergence des adventices | Riz sauvages en végétation active, bien développés |

**2) Caractéristiques des variétés à cycle moyen vulgarisées**

| Variétés | BG 90-2 | Gambiaka Suruni | Sahélika | Jama Jigui |
|---|---|---|---|---|
| Nom | BG 90-2 | Kogoni 91-1 | Ecia | Leizong |
| Origine | Sri-lanka | IER | Cuba | |
| Performances en tests | 6 T | 6 T | 6 T | 6 T |
| Rendement potentiel | 10 T | 10 T | 8 T | 8 T |
| Indice récolte | | 80 % | | |
| Taille en cm | 100 | 95 | 110 | 105 |
| Cycle semis maturité jours | Moyen 130 | 135-140 | 140 | 135 |
| Port | Dressé | Dressé | Erigé | Dressé |
| Tallage | Très bon | Bon | Bon | Bon |
| Feuille paniculaire | Erigée | Erigée | Semi érigée | Semi-dressé |
| Couleur paddy | Jaune paille | Doré | Jaune paille | Jaune paille |
| Longueur paddy | 9.2mm | 9.5mm | 6.71mm | 6.98mm |
| Largeur paddy | 2.7mm | 1.9mm | 2.14mm | 2.47 |
| Poids 1000 grains | 28g | 23g | 29g | 28g |
| Aristation | Semi-mutique | Mutique | Mutique | Mutique |
| Forme du bec | Légèrement courbé | Légèrement courbé | Semi-courbé fermé | Semi-courbé fermé |
| Couleur caryopse | Blanc | Blanc | Blanc | Blanc |
| Pourcentage au décorticage | 75 % | 65 % | 75 % | 75 % |
| Valeur marchande | Bonne | Très bonne | Bonne | Bonne |
| Photosensibilité | Insensible | Insensible | | |
| Dormance | 4 semaines | 3 semaines | 2 semaines | 2 semaines |
| Réaction aux engrais | Bonne au tallage | Bonne | Bonne au tallage | Bonne au tallage |
| Qualité culinaire | Bonne | Très bonne | Assez bonne | Assez bonne |
| Virose RYMV | Sensible | Moyennement sensible | Moyennement sensible | Moyennement sensible |
| Cecidomyie | | | Tolérante | Tolérante |
| Foreur de tiges | | Tolérante | | |
| Pyriculariose | Sensible | Sensible en zone humide | | |
| Saison de culture | Humide | Humide | Humide | Humide |

**Annex 2 (see excel file)**

**Cashflow analysis**

**Table: PIV building costs**

| N° | Site | Area (ha) | Project Cost (F CFA HT) | | Total Cost per PIV (F CFA) | | | Cost per hectare (F CFA) |
|---|---|---|---|---|---|---|---|---|
| | | | Works done by beneficiaries | Civil engineer works | Small material Acquisition | Equipment of pumping | | |
| 1 | Abandou Banda | 14.32 | 6,693,750 | 1,445,884 | 808,380 | 9,000,000 | 17,948,014 | 1,253,353 |
| 2 | Hondou Tchabya | 14.00 | 6,247,500 | 2,145,422 | 791,500 | 9,000,000 | 18,184,422 | 1,298,887 |
| 3 | Bangou Banda | 24.00 | 10,710,000 | 2,555,377 | 1,353,000 | 13,500,000 | 28,118,377 | 1,171,599 |
| 4 | Lafia | 22.50 | 10,040,625 | 1,698,467 | 1,265,875 | 13,500,000 | 26,504,967 | 1,177,999 |
| 5 | Kandjiga | 56.00 | 26,328,750 | 4,399,851 | 3,151,000 | 30,000,000 | 63,879,601 | 1,140,707 |
| 6 | Dareya | 52.00 | 23,205,000 | 4,902,731 | 2,927,000 | 30,000,000 | 61,034,731 | 1,173,745 |
| 7 | Saragna | 10.00 | 6,693,750 | 2,977,064 | 580,500 | 8,000,000 | 18,251,314 | 1,825,131 |
| 8 | Dalitiéré | 33.69 | 13,387,500 | 2,306,937 | 1,882,148 | 15,000,000 | 32,576,585 | 966,951 |
| 9 | Far Far | 59.00 | 29,006,250 | 3,672,632 | 3,322,250 | 30,000,000 | 66,001,132 | 1,118,663 |
| 10 | Sororia | 105.00 | 44,625,000 | 6,800,211 | 5,893,750 | 50,000,000 | 107,318,961 | 1,022,085 |
| 11 | Baifandou | 106.00 | 45,963,750 | 6,340,863 | 5,953,000 | 48,000,000 | 106,257,613 | 1,002,430 |
| | **TOTAL** | **497** | **222,901,875** | **39,245,438** | **27,928,403** | **256,000,000** | **546,075,716** | **1,099,828** |

**Project funding options and cashflows**

**Option 1 a**

| Years | Off S rice area | Yield | Production | Unit Price | Prod Value | Sea rice area | Yield | Product | Unit Price | Prod. Value | Wheat area | Yield | Product | Unit Price | Prod. Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 390 | 0 | 0 | **120** | **0** | **1300** | 0 | **0** | **120** | 0 | **260** | **0** | 0 | **200** | 0 |
| 1 | 390 | 4500 | 1755000 | **120** | **210600000** | **1300** | 4500 | **5850000** | **120** | 702000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 2 | 390 | 5000 | 1950000 | **120** | **234000000** | **1300** | 5000 | **6500000** | **120** | 780000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 3 | 390 | 5500 | 2145000 | **120** | **257400000** | **1300** | 5500 | **7150000** | **120** | 858000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 4 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 5 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 6 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 7 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 8 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 9 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |
| 10 | 390 | 6000 | 2340000 | **120** | **280800000** | **1300** | 6000 | **7800000** | **120** | 936000000 | **260** | **4000** | 1040000 | **200** | 208000000 |

| Years | Off Ri Op C | Sea Ri OpC | WheaOpC | Total OpCosts | Invest ment | Total cost | TotProdValue | Cashflow |
|---|---|---|---|---|---|---|---|---|
| 0 | **0** | 0 | **0** | 0 | 1688733341 | 1688733341 | 0 | - 1688733341 |
| 1 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1120600000 | 454657500 |
| 2 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1222000000 | 556057500 |
| 3 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1323400000 | 657457500 |
| 4 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| 5 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| 6 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| 7 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| 8 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| 9 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| 10 | **157657500** | 405325000 | **102960000** | 665942500 | **0** | 665942500 | 1424800000 | 758857500 |
| | | | | | | **TIR** | | **35 %** |

**Option 1 b**

| Years | Off S rice area | Yield | Production | Unit Price | Prod Value | Sea rice area | Yield | Product | Unit Price | Prod. Value | Potatoes | Yield | Product | Unit Price | Prod. Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 390 | 0 | 0 | **120** | 0 | **1300** | 0 | 0 | **120** | 0 | 260 | 0 | 0 | 200 | 0 |
| 1 | 390 | 4500 | 1755000 | **120** | 210600000 | **1300** | 4500 | 5850000 | **120** | 702000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 2 | 390 | 5000 | 1950000 | **120** | 234000000 | **1300** | 5000 | 6500000 | **120** | 780000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 3 | 390 | 5500 | 2145000 | **120** | 257400000 | **1300** | 5500 | 7150000 | **120** | 858000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 4 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 5 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 6 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 7 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 8 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 9 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 10 | 390 | 6000 | 2340000 | **120** | 280800000 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 15000 | 3900000 | 200 | 780000000 |

| Years | Off S rice area | Shallot area | Yield | Production | Unit Price | Prod. Value | Wheat area | Yield | Product | Unit Price | ProdValue |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 390 | **260** | 0 | 0 | 150 | 0 | **260** | **0** | 0 | **200** | **0** |
| 1 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 2 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 3 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 4 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 5 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 6 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 7 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 8 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 9 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |
| 10 | 390 | **260** | 40000 | 10400000 | 150 | 1560000000 | **260** | **4000** | 1040000 | **200** | **208000000** |

| Years | Off S rice area | Off Ri Op C | Sea Ri OpC | PotaTOpC | ShallOpCo | WheatOpC | Total OpCosts | Invest ment | Total cost | TotProdValue | Cashflow |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 390 | **0** | 0 | 0 | 0 | **0** | 0 | 1673981841 | 1673981841 | 0 | -1673981841 |
| 1 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3355560000 | 1535100500 |
| 2 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3456960000 | 1636500500 |
| 3 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3558360000 | 1737900500 |
| 4 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| 5 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| 6 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| 7 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| 8 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| 9 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| 10 | 390 | **157657500** | 405325000 | 109785000 | 1044732000 | **102960000** | 1820459500 | 0 | 1820459500 | 3659760000 | 1839300500 |
| | | | | | | | | | **TIR** | | **97 %** |

**Option 2 a**

| Years | Sea rice area | Yield | Production | Unit Price | Prod Value | Shallot area | Yield | Product | Unit Price | Prod. Value | Potatoes | Yield | Product | Unit Price | Prod. Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | **1300** | 0 | 0 | **120** | 0 | 260 | 0 | 0 | 150 | 0 | 260 | 0 | 0 | 200 | 0 |
| 1 | **1300** | 4500 | 5850000 | **120** | 702000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 2 | **1300** | 5000 | 6500000 | **120** | 780000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 3 | **1300** | 5500 | 7150000 | **120** | 858000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 4 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 5 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 6 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 7 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 8 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 9 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |
| 10 | **1300** | 6000 | 7800000 | **120** | 936000000 | 260 | 40000 | 10400000 | 150 | 1560000000 | 260 | 15000 | 3900000 | 200 | 780000000 |

| Years | Sea rice area | Tomatoarea | Yield | Production | Unit Price | Prod. Value | Sea Ri OpC | PotaTOpC | Shall OpCo | Toma OpC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | **1300** | 390 | 0 | 0 | 150 | 0 | 0 | 0 | 0 | 0 |
| 1 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 2 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 3 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 4 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 5 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 6 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 7 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 8 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 9 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |
| 10 | **1300** | 390 | 20000 | 7800000 | 150 | 1170000000 | 405325000 | 109785000 | 1044732000 | 194298000 |

| Years | Sea rice area | Total OPC | Investment | Total Cost | TotProd Value | Cashflow |
|---|---|---|---|---|---|---|
| 0 | **1300** | 0 | 1997834841 | 1997834841 | 0 | - 997834841 |
| 1 | **1300** | 1754140000 | 0 | 1754140000 | 4212000000 | 2457860000 |
| 2 | **1300** | 1754140000 | 0 | 1754140000 | 4290000000 | 2535860000 |
| 3 | **1300** | 1754140000 | 0 | 1754140000 | 4368000000 | 2613860000 |
| 4 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| 5 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| 6 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| 7 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| 8 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| 9 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| 10 | **1300** | 1754140000 | 0 | 1754140000 | 4446000000 | 2691860000 |
| | | | | | **TIR** | **126 %** |

**Option 2 b**

| Years | Sea rice area | Yield | Production | Unit Price | Prod Value | Wheat area | Yield | Product | Unit Price | Prod. Value | Shallot area | Yield | Product | Unit Price | Prod. Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | **1300** | 0 | 0 | **120** | 0 | 390 | 0 | 0 | 200 | 0 | 390 | 0 | 0 | 150 | 0 |
| 1 | **1300** | 4500 | 5850000 | **120** | 702000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 2 | **1300** | 5000 | 6500000 | **120** | 780000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 3 | **1300** | 5500 | 7150000 | **120** | 858000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 4 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 5 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 6 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 7 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 8 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 9 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |
| 10 | **1300** | 6000 | 7800000 | **120** | 936000000 | 390 | 4000 | 1560000 | 200 | 312000000 | 390 | 2000 | 780000 | 150 | 117000000 |

| Years | Sea rice area | Sea Ri OpC | WheatOpC | ShallOpCo | Total OPC | Investment | Total Cost | TotProdValue | Cashflow |
|---|---|---|---|---|---|---|---|---|---|
| 0 | **1300** | 0 | 0 | 0 | 0 | 1763004341 | 1763004341 | 0 | -1763004341 |
| 1 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1131000000 | 353545000 |
| 2 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1209000000 | 431545000 |
| 3 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1287000000 | 509545000 |
| 4 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| 5 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| 6 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| 7 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| 8 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| 9 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| 10 | **1300** | 405325000 | 154440000 | 217690000 | 777455000 | 0 | 777455000 | 1365000000 | 587545000 |
| | | | | | | | | **TIR** | **25%** |