Norias and small scale Irrigation: changing the face of upland farming

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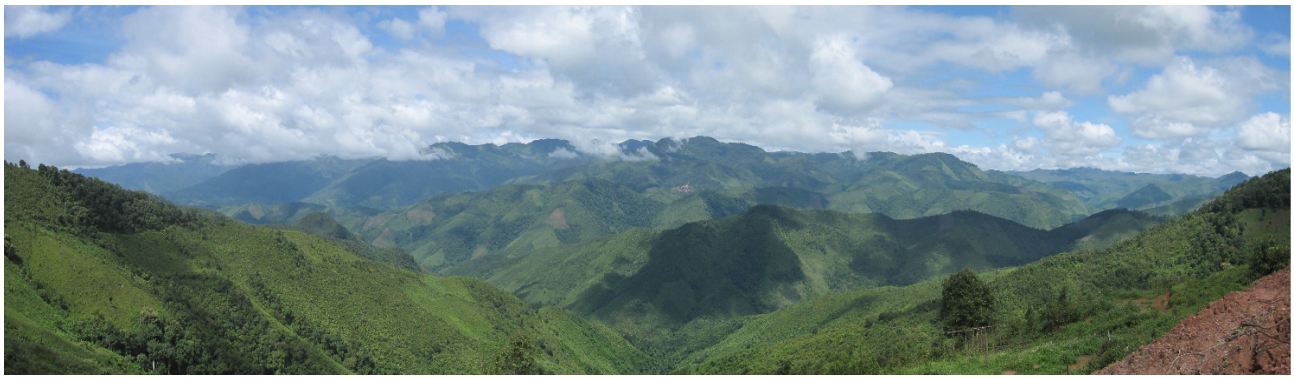
RATIONALE

Lao PDR is ranked as having the 133rd Human Development Index out of 180 countries in the 2009 United Nations Development Program's Human Development Report. In 2004, 71 percent of its population lived on less than US$2 a day and 23 percent on less than US$1 a day[1]. According to the Asian Development Bank (ADB)[2], access to rice (the main staple food) remains "the single most important factor determining the welfare status of the Lao people in rural areas. Rice contributes to almost 70% of the calorie and protein intake of Lao people. For this reason, achieving self-sufficiency in rice at the national level has been a top priority goal for the country".

However significant disparities exist at the national level. Generally speaking, rice seems to be most deficient in the upland areas where the rain fed upland rice cultivation (slash and burn) is predominant. The productivity of this cultivation method is usually lower than the irrigated rice cultivation method (paddy cultivation). Rain-fed upland cultivation had an overall average yield of 1.8 t/ha against 4.4 t/ha for the irrigated lowland cultivation in 2004[2].



Upland area: view from Samet village, Saysathan district, Laos

In food insecure areas, irrigated cultivation could also have other significant advantages over the rain fed cultivation as irrigation systems can enable the cultivation of a second dry season crop. No addition of fertilizer is required in the case of a single yearly rice crop. Irrigated cultivation is less prone to climatic factors than rain fed cultivation. Irrigated cultivation therefore has a high potential to increase the productivity and diversification of subsistence farming in food insecure areas. For food insecure populations irrigated cultivation can enable higher and safer production, higher diversity and, in turn enable farmers to engage in other activities[3].

Upland villagers often do not have the means to develop irrigated cultivation, mainly because they lack the technical know how required. Engaging in new farming techniques without external support is high risk for a food insecure population. Other factors generally impair the development of irrigation in upland areas. The most obvious is the lack of potential for large irrigation schemes due to the topography. Road accessibility is also often an issue since the building of large irrigation schemes using concrete requires the transportation of a significant amount of materials. However numerous areas of say 0.5 to 10 ha could often be irrigated in small bottom valleys in upland areas provided that suitable technical solutions are implemented.

[1] Executive Brief: Lao PDR Comprehensive Food Security and Vulnerability Analysis, WFP, 2006
[2] Lao PDR: an evaluation synthesis on rice, ADB, 2006
[3] Rice Today, issue no 6, International Rice Research Institute (IRRI)

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CARE is implementing a rural development project funded by the Swiss Agency for Development and Cooperation (SDC) in 19 Prai ethnic villages of Saysathan district. This district is ranked among the 47 poorest districts of the country. Within the target area, almost all villages are exclusively cultivating rain fed upland rice (slash and burn). Overall, project target villages are rice deficient with an average self sufficiency of 9.4 month per year. Disparities exist since the 25% poorest households produce on average the equivalent of 6 months worth of rice[4]. One of the objectives of the project is to improve rural livelihoods and reduce vulnerability of poor households. Increased rice productivity and improved access to rice therefore contributes directly to achieving these objectives.

Target village for the water Wheel and irrigation Trials

The theory

Provided that the project implements suitable technical solutions and support, the introduction of the irrigated rice cultivation method, where possible within the target area, will positively impact livelihoods by resulting in increased rice production and increased production efficiency.

The objective

The aim is to trial the noria (water-wheel) technology in parallel with other relevant irrigation means. On the job training will be provided for the building, operation and maintenance of systems in two target villages. The trial will then be assessed and may be replicated elsewhere at the district or province.

Step by step Implementation

a) Identification of suitable technical solutions

To enable the identification of suitable technical solutions, a review of all aspects which hinder the building of irrigation schemes in upland areas was first made. Potential problems and solutions were identified as follows:

- Lack of villager know how in terms of site identification and irrigation techniques. This often results in suitable land in bottom valleys being un-utilised unless surveys are carried out by project team.
- High labour requirements for the building of schemes and land terracing in the first year is often required. Poor families can often not undertake without support, therefore utilising Cash for Work in parallel with free labour contributions from selected villagers will provide the support required for the terracing and digging of canals.
- Lack of knowledge about this cultivation method resulting in significant risks if technical support is not provided. Need for CARE staff to support villagers with on the job training.
- Lack of required production means (seeds, trained buffalo etc…). Provision of 3 different seed varieties to be made by project together with training on ploughing tools making and buffalo training.
- There is a significant issue in regards to accessibility for the transportation of materials. Sustainable technical solutions have to be carefully selected which revolves around the use of materials available at the village level. Several technical solutions were retained as suitable and included stream diversion, gabion or wooden dams and norias.

[4] PARUA project Baseline, Steeve Daviau, 2009

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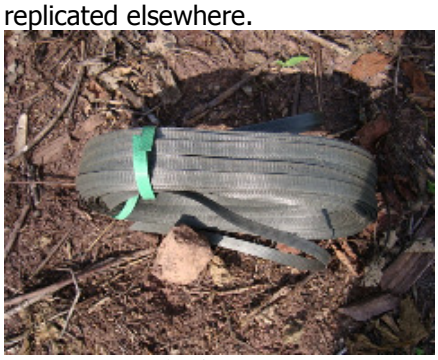
b) Feasibility study

This activity required initial feasibility studies to be carried out with villagers in the target villages. As a result sites were identified as suitable in five villages.

c) Study tour for villagers on Noria technology.

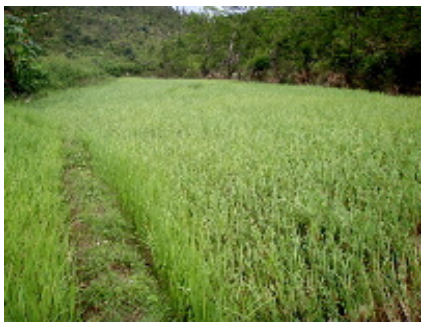
Given the initial interest expressed by villagers during surveys and the presence of suitable areas for the development of irrigation, a study tour was organised in Samneua on norias. The visit was to facilitate the decision making process of potential target families concerning the implementation of the activity in their village. This study tour allowed villagers to directly gather information from Samneua farmers about the noria operation and maintenance requirements. Villagers also saw the wheels functioning.

Water wheels or norias are a simple yet effective tool. Their role is to elevate water from a stream by using the strength of the stream itself; as such they can irrigate areas that other traditional means are not be able to irrigate because of the height differential between the land and the water source. Norias are easily built and maintained using local materials gathered by villagers. The only external material required is a plastic strap which is low cost and can be transported easily. This represents a significant advantage especially for remote areas: due to their low material requirement, norias can be built anywhere with low labour input and costs. Transferring this knowledge and skills to build and operate norias should be relatively easy for the villagers and it is apparent that this technology has the potential to be easily replicated elsewhere.



Plastic strap

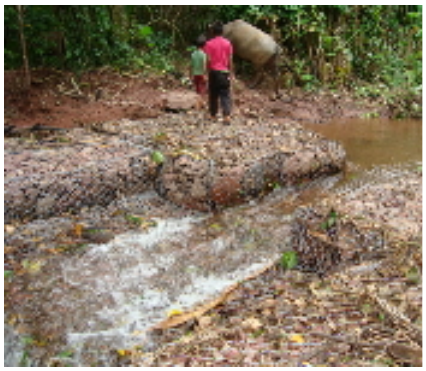
Noria in Samneua

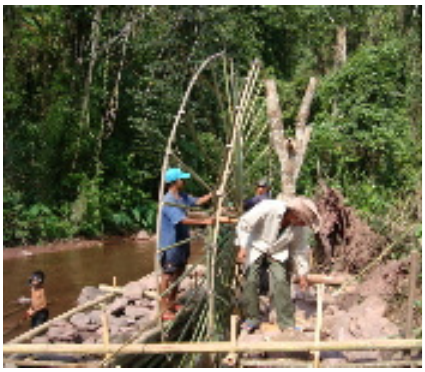


Paddy field irrigated with Norias

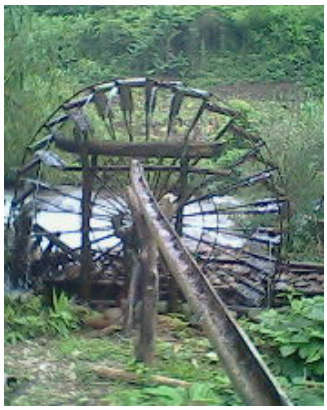
d) Construction of water wheels and irrigation systems

Four norias were initially built in two target villages with CARE's support and training. The initial two water wheels where built by subcontracted farmers form Samnuea (where the study tour took place), the subsequent water wheels were built by the local farmers with trainer's assistance. The farmers then spontaneously built an additional five water wheels, bringing the total number of waterwheels to nine. Water diversion and dams were also built by the project in other areas.





Building of gabion dam and water wheel



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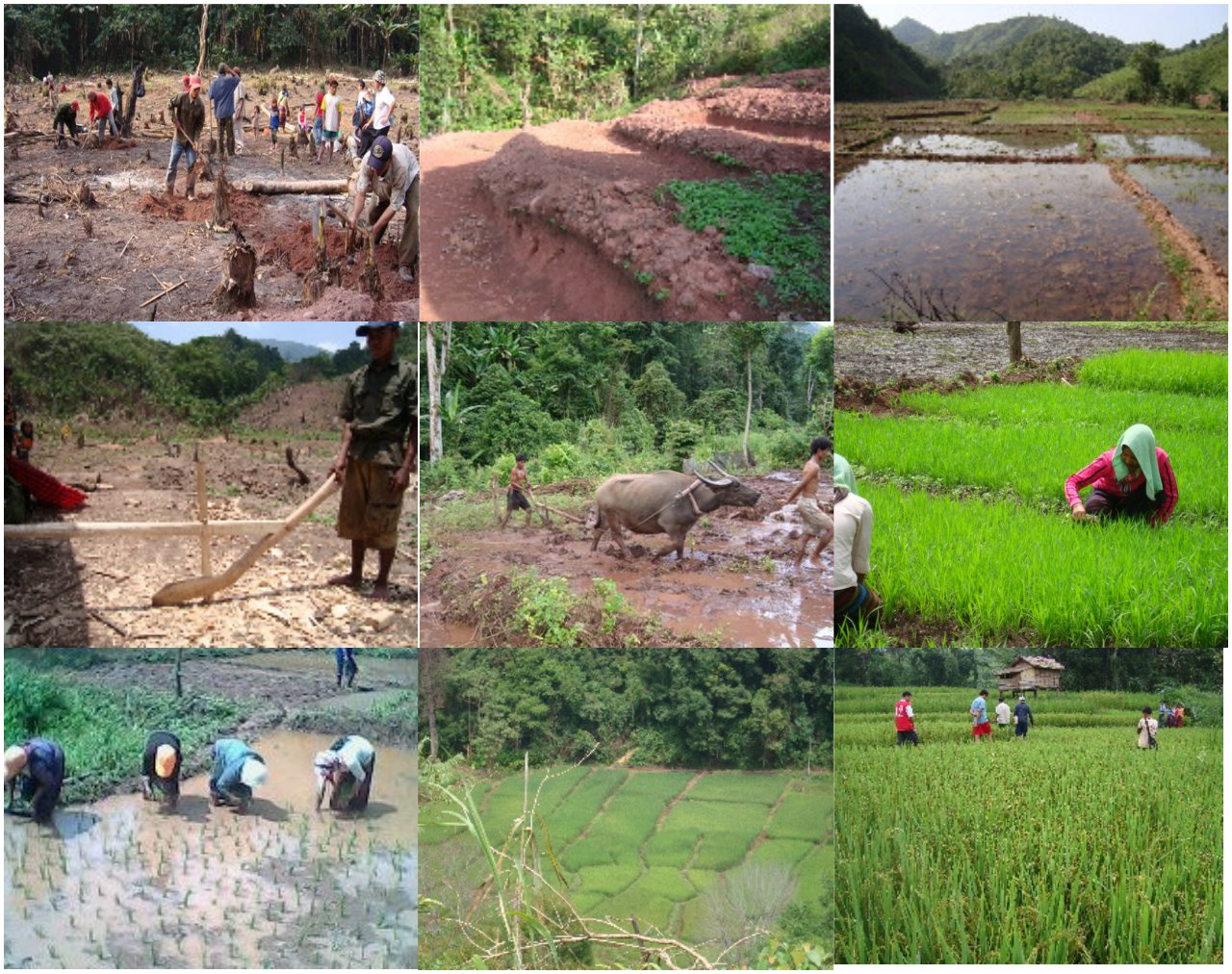
e) Training on wetland cultivation

Comprehensive training was delivered to the villagers on the construction of irrigation systems. However, for this activity to be successful the villagers need to also develop understanding and competence in:

- Terracing of the paddy field, ensuring correct water levels and facilitating water flow through the field.
- Planting and tending of the rice and rice beds; training is required as paddy planting involves a different technique than upland farming.
- Making of ploughs, rakes and other ploughing materials
- Training in the use of buffalo to assist in the paddy field cultivation.

This on the job training was performed successfully by embedding project staff in the village (farmers with extensive experience on irrigated cultivation). For three months they worked alongside, supported and provided training and advice to the farmers on all aspects of the activity. This gave the farmers confidence and ensured any obstacles were addressed and overcome quickly and consultatively. Some financial help was also provided by the project to villagers as cash for work for land terracing and digging of irrigation canals[5]. Three different seed varieties were also provided to farmers.



Training steps at one glance: field terracing, making of tools, buffalo taming, establishment of rice nurseries, rice transplanting

[5] Please refer to "Annex 2: Fact sheet for the design of irrigation activities" for quantitative data

f) Post Harvest Monitoring

Post harvest monitoring included:

- The determination of yields for target families by weighting sample rice bags and counting the total number of harvested rice bags)
- Interviews with six target families after harvest (both husband and wife)

Results are the followings:
In terms of yields, **23.6 tons of rice was produced** on newly irrigated areas. **The average yield** across the 37 target families **was 1.9 ton/ha**. It ranged from 1 to 4.8 tons/ha in the first target village and from 0.3 to 2.5 ton/ha in the second target village. Yields were irrespective of the irrigation technique used (stream diversion, gabion or wooden dam and Noria). Noria enabled to harvest yields ranging from 0.9 to 4 tons/ha.

Yields are lower than the national average yield for irrigated rice cultivation (4.4 ton/ha). This was anticipated. Of note:

- No important problem occurred. Rice stems were reported as being healthy towards the end of the growing season. Fears were raised at that stage by district staffs on the fact that such healthy stems may not provide high yields. This phenomenon is said to be common during the first year of cultivation[6].
- Yields are reported to increase over the years as a result of progressive and natural processes.
- The learning process of villagers will continue to be supported and should also result in higher yields.
- The lowest yields can mainly be explained by the unusual rat predation which occurred in two villages and affected some of the wetland rice fields. The extent of this rat predation has been reported in several other districts of the Lao northern provinces but is expected to reduce in the future.

Yields were also measured in rain fed upland rice fields for local comparison. Yields measurements were made for eight families (four per village). Upland rice yields were low. They ranged from 0.87 to 1.68 ton per ha in the first village and from 0.31 to 0.73 ton per ha in the second village. The average for the eight families was 1 ton per ha. These very low yields can be explained by the rat predation (This rat predation was reported as being less important on irrigated fields than on rain-fed upland rice fields because water levels on irrigated fields had a protective effect against rat intrusion). However, based on villagers testimonies it seems that even without rat predation, upland rice yields are generally lower than the national average in this area.

☛**Fields irrigated as part of the project therefore had yields that were:**

- **Higher than the national average figures for rain fed upland fields (1,8 ton/ha)**
- **Almost double compare to the local rain fed upland field yields (1 ton/ha).**

The yields of irrigated field are expected to increase in the next years.

As far as qualitative data is concerned the six interviewed families reported that:

1. Villagers liked and embraced the technology and can see its application in their village,
2. The skills and knowledge to build water wheels is easily learnt and transferred,
3. The rice yield is significantly improved,
4. Villagers can see very significant improvements in terms of reduced labour requirements.
    a. The most significant time savings come from the absence of significant weeding operations which is a real burden for rain fed upland rice cultivation. Both the male and women benefit from this decrease in labour requirements.
    b. Some irrigated fields are close to the village. This resulted in a significant workload reduction when compared with upland rain fed cultivation. The physical act of carrying the rice from

[6] Communication from Mr Bougnang, deputy chief of Saysathan district department of agriculture

upland rice fields is labour intensive and time consuming. The six families would save on average 40 to 65 working days if they produced all their rice production near the village[7].

5. Five of the six interviewed families have more land that they intend to irrigate themselves in the following years. At the village level, this replication may result in a doubling of irrigated surfaces next year.
6. Farmers indicated that the labour saved in future years will be used to repair their houses, grow a second crop (dry season vegetable farming), cultivate forage for the livestock and implement other income generating activities.

The cash for work activity had indirect benefits as some villagers bought some assets with the cash they received for their work.

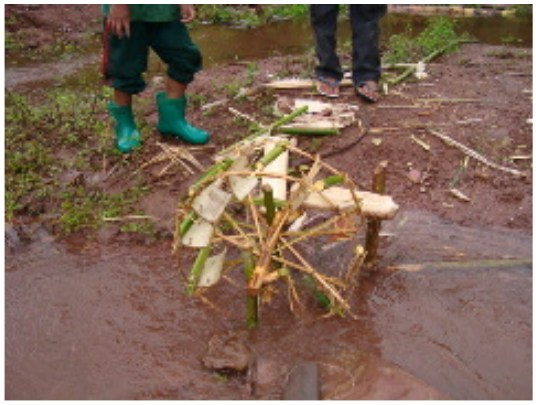
Replication

Replication has occurred spontenaously at the village level as evidenced with the construction of five supplementary wheels built by villagers immediately after the project wheels were built. According to villagers they will carry on expanding their irrigated fields (or irrigate new areas) in the coming years.

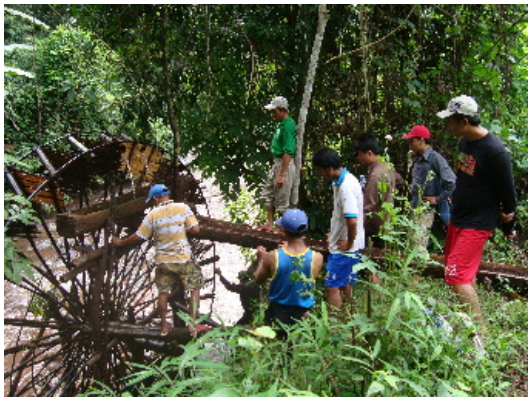
One study tour took place with staff from department of agriculture from four districts just before the harvest. Conclusions drawn by district staff include:

- The activity was adapted to the upland environment constraints. Norias are particularly well adapted to this environment because of their low cost.
- This activity could also be developed in other districts in Sayabouli. District staff requested a technical manual on norias for replication in their districts. [8]

Given the low cost and the impact of the activity, it is believed that this activity has a high potential for replication in other upland areas of Laos.



A positive sign: children copying the water wheel to make a to scale version for fun!



Study tour with representatives from agriculture departments from other districts

[7] Please refer to Annex 2 for further details on quantitative data
[8] This manual is now available in Lao language with CARE

Conclusion

Small scale irrigation systems were built in bottom valleys of two remote upland villages. Potential for irrigated cultivation was initially unknown in these villages probably because of the absence of large irrigation schemes. Rice irrigated cultivation had never taken place in these villages. Villagers had no technical knowledge about irrigated cultivation techniques prior to the project.

Irrigation techniques included stream diversion, gabion and wooden dams and norias. These systems have proven to be well adapted for the building of small scale irrigation systems in bottom valleys of remote upland villages. They were simple to build, required a minimum of external construction materials and are low cost.

Due to the selection of irrigation systems, the provision of construction materials by the project was limited. The activity was implemented with a participative approach and field owners were required to contribute free labour. Limited cash for work support was also provided. These factors were important contributors to the success of the activity. The essential support was technical expertise and on the job training. The embedding in target villages of external farmers with practical knowledge of this cultivation was key to the success of the activity.

Indicators of success include improved yields, spontaneous replication on non project target areas, and village plans to expand systems next year.

As a result of the project, target families have access to sustainable and increased productivity. This has a significant impact on food insecurity. More secured rice self sufficiency has been made (higher production, diversification of production means irrigated/upland) and people have more time to engage in other food or income generating activities. After the first harvest, people have planned to grow vegetables in the dry season, grow forage for animals or cash crops on upland land freed up from rice cultivation.

A local rice production enabling increased self sufficiency in remote areas also probably makes sense in the current global context. The demand for rice is expected to grow substantially especially in Laos where the population growth is high[9]. Rice production costs of small scale irrigation systems will probably not be competitive when compared with large scale irrigation schemes at least in the short term. However, recent fluctuations in petrol and food commodity prices have demonstrated that it may not be safe to rely for instance on the sale of a cash crop to then purchase staple food especially when transportation distances are high. Local production requiring minimum transportation is moreover more environmentally friendly in the context of the global climate change.

There is potential for this activity to be replicated in similar socio economic and geographical areas in Laos.

[9] Lao PDR: an evaluation synthesis on rice, ADB, 2006

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For further information/contacts:

1. Please refer to the following web links for pictures and video on the building and operation of water wheels:
   http://picasaweb.google.com/parua209/09WaterWheelAndIrrigationSathanSysaithong?authkey=Gv1sRgCL-d4aSE2tX8zgE&feat=directlink
   http://picasaweb.google.com/parua209/Video?authkey=Gv1sRgCO7GzOH9lrD7-gE&feat=directlink
2. For further information please contact: Boris FRANGI, Provincial Coordinator, boris@carelaos.org or Sysouphan PHONEKHAMPOU, project manager, sysouphan@carelaos.org; Tel/fax: 00 856 (0)74 211 064

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2. Lao PDR: an evaluation synthesis on rice, A Case Study from the 2005 Sector Assistance Program Evaluation for the Agriculture and Natural Resources Sector in the Lao People's Democratic Republic Njoman George Bestari & Samjhana Shrestha, Caren Joy Mongcopa Operations Evaluation Department Asian Development Bank, 2006

3. Looking up in the uplands, Adam Barclay, Rice Today, issue no 6, October-December 2007 International Rice Research Institute (IRRI), www.irri.org

4. PARUA II project Baseline, Steeve Daviau, 2009

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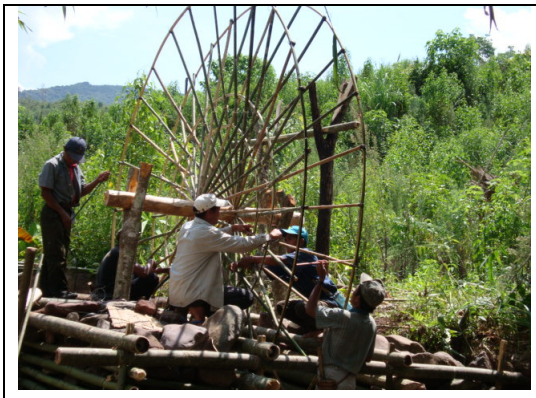
Annex 1: Water Wheels in Action

Mr. Song and his wife Mrs. Nang live in the village of Sysaithong in Saysathan district. 13 people live in their household. In the past, their family had never cultivated irrigated rice. Their rice production exclusively relied on rain fed upland rice cultivation.

This year Mr Song and his family cleared and terraced 3750 m2 of land. He did the first 1500 m2 as a free contribution and then was paid by the project a cash contribution of USD 33 for the remaining 2250 m2. He then attended the on the job training on water wheel construction together with other villagers. The training took place in his village. Villagers mastered the construction very quickly and the third and fourth wheels were unexpectedly built by the villagers themselves under minimal supervision from trainers.



Mr Song building a water wheel with other villagers as part of the on the job training

Mr Song, water wheel trainers and other trainees after the completion of the wheel

Mr Song had no buffalo which could have been tamed during the project. He however could borrow a newly tamed buffalo from a relative in the village. "During the rice growing season, rats damaged about 15% of my wetland rice. Small birds also caused some damages but to a lesser extent". Mr Song harvested 1 ton of rice on his newly irrigated field which represents a yield of 2.68 ton per ha.

Mrs. Nang thinks that "this cultivation enables to save a lot of time when compared with the rain fed upland rice cultivation except for the rice transportation step since our paddy fields are located at the same distance from the village than our upland fields (2 hours walk). I like the paddy cultivation very much because it frees up a lot of time overall. This free time enables to engage in other activities."

According to Mr Song, "The training on noria and irrigated rice cultivation was very useful. I think I can build, repair and operate the water wheels myself now. I still have at least 5,000 to 10,000m^2 which were not irrigated yet this year and which I intend to irrigate from next year onwards. In order to irrigate this new area, I will build a dam and build more canals. If possible I would need further training and materials for the dam building. By 2011, I think we will have cleared, terraced and irrigated all the land which can be irrigated. Then I think we will stop rain fed upland rice cultivation and only cultivate wetland rice. My family will use the free time to make gardening for household consumption".

"The irrigated cultivation has allowed us to produce rice alcohol this year. As we also cultivated rain fed rice as usual, we had some rice surplus this year and we have already generated an income of kip 2,500,000 (equivalent to USD 294) from the alcohol sale. There will also be more feed for the pigs raised by the family.

He thanks CARE for the technical training and support they provided and tells us that now villages have seen his water wheel in action other villagers are now very interested in building and using water wheels or irrigation systems which is extremely positive for the entire village.

Boris FRANGI, Ponglamphanh LOTKHAMNGA, Sardi CALVER, PARUA II project team

Annex 2: Fact sheet for the design of irrigation activity

The following data summarizes data which may be useful for the design of similar activity in other areas. Figures are indicative only

1. **Labour requirements**
   a. Terracing 0.5 hectare required about 5 people for 10 days i.e. 100 labour days per ha.
   b. The initial planting of rice required 3 to 4 people during 5 days for 0.2 hectares i.e. 75 to 100 labour days per ha if no buffalo is used. This labour requirement will then reduce in subsequent years as skills are improved.
   c. Making of plough, rake and other ploughing materials required 3 people for 3 days per tool set (including a CARE trainer)
   d. Buffalo taming: The training for the taming of 1 to 6 buffaloes requires 3 people for 1 week.
   e. Building of each wheel took approximately 45 labour days with tasks including: 5 labour days for the wood and bamboo collection (5 people during 1 day); 15 labour days for the stone structure (5 people during 3days); 25 labour days for construction (5 people during 5 days)

2. **Budget:**
   f. **Cash for work:** USD 2900 were paid by the project as cash for work for 12.6 ha representing an average of USD 230 per ha. This amount was mainly paid for land terracing and digging of canals. For land terracing a free labour contribution was requested on 1500 m2 per family. The project then paid USD 51.5 for up to 3500 m2 of terraced land. For canal digging, kip 24,000 i.e. USD 2.8 per m3 of dug soil were paid.

   g. **Gabion dams:** gabion baskets provided to villagers (**)

no	Irrigated area (ha)	Number of gabions	Total Price (USD)
1	4,2	29 (dam of 8*3*1,5) + canal	638 to 928
2	0,4	11 (dam of 6*3*1,5 m)	242 to 352
3	0,75	23 (dam of 11*3*1,5)	506 to 704

(**) number of gabions is local river configuration dependant

   h. **Water wheels:** about 1 kg of plastic strap is needed per water wheel. This cost represents less than USD 20 per water wheel.
   i. **Production value:** Based on the local sale price of rice of kip 1275 kip to 1500 per kg, the total production of 23.6 tons was worth USD 3540 $ to 4150 $.

3. **Water wheels**

In Samneua it was observed that between 3500 m2 to 5000 m2 can be irrigated by one single water wheel. If properly maintained, a wheel can last more than 20 years (as was the case of one wheel during the study tour). The water wheels can effectively elevate water up to 5 meters. As part of the project, one single noria could supply enough water to irrigate up to 3800 m2 in the first year of cultivation. 18 effective days were required for surveys for noria potentials in 12 villages. 12 effective days in the field were required for the training on water wheel construction in 2 villages

4. **Labour savings**

The absence of weeding for irrigated paddy fields represents the main source of saving in terms of labour when compared with the rain fed upland cultivation. However, when irrigated fields are located near the village, significant labour savings can also take place on the rice transportation step.
As far as the 6 interviewed families were concerned, their upland rice fields were located at 3 hours away from the village (average return trip) for an average rice production of 3.3 ton per family. As such with an average rice load of 25 kg per trip and 2 to 3 trips per day (6 to 9 hours of rice transportation per day), it requires 43 to 65 working days on average per family to bring the rice back from upland fields to the village every year.

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