Enhancing productivity of land and labour through small-scale mechanisation for subsistence farmers in Papua New Guinea and Solomon Islands

SUMMARY OF RESULTS

Prototype small-scale farm machines such as a solar dryer, the ‘Kisar’ manual rice mill and a peanut sheller have been designed, constructed and piloted in several farming communities in Papua New Guinea and the Solomon Islands. A farmer participatory research approach allowed farmers to learn by doing, resulting in them gaining the confidence to make their own machines. The approach also resulted in a better understanding of farmer realities, including the use and lack of access to farm machinery, particularly for rice and peanut production. The research capacity in the design and development of farm machines was enhanced and mini-engineering workshops and a thermo-physical laboratory were established. An economic assessment of the prototype machines showed that the ‘Kisar’ rice mill was the most cost beneficial machine as compared to other rice mill machines as its usage in rice growing communities reduces transport and milling costs for farmers who normally bring their rice to rice mills (for household consumption) in urban centres.

BACKGROUND

Most of the rural farmers in Papua New Guinea and the Solomon Islands use traditional hand tools such as machetes, spades and wooden digging sticks. Using these tools requires many man hours with limited returns as compared to mechanised agricultural production inputs, and as such contributes to low land and labour productivity. This is against the backdrop of both an increasing population and demand for food, as well as degradation of natural resources, particularly declining soil fertility due to shorter fallow periods. Moreover, insufficient access to farm machinery, its limited use, repair and maintenance, combined with imported machines that are not adapted to local circumstances and with limited R&D in farm machinery, restrict a needed increase in farm productivity.

The inefficient, high-labour input production systems with low returns for farmers formed the premise of the project to improve agricultural productivity in farming communities through farm mechanisation.

The project sites in Papua New Guinea (Madang, Morobe and Eastern Highland provinces) and the Solomon Islands (Western and Isabel provinces) were selected because of their dominant rice and peanut production and related demand for access to farm machinery. The demand for farm machinery for other major crops such as sweet potato, taro and banana is low, partly because these crops are not commercially grown as yet. Rice and peanut were introduced in Papua New Guinea nearly 100 years ago by missionaries and European colonisers, but access to machinery, particularly rice mills, has remained one of the major production constraints. Although motorised rice mills were introduced, farmers face continuous breakdowns and difficulties to access spare parts. Rice is not a staple crop, partly because farmers do not get the maximum production output with attractive returns from their limited investments due to the lack of an ideal milling solution. The challenge with milling services has resulted in declining rice production and rice farming being restricted to certain isolated rural communities that use locally invented or traditional milling technologies, such as the wooden ‘Kisar’ mills.

Baseline surveys to ascertain the understanding and scope of farm mechanisation were followed by the designing and prototype testing of small agricultural machines for smallholder farmers, and farmer training on usage and reproduction. The farmer participatory methodology increased awareness of these machines through farmer field days, videos, print media, social media, radio and agriculture shows.
Several stakeholders with complementary roles collaborated on the project. In Papua New Guinea: an agricultural research institute to design and develop farm machinery, a farm machinery manufacturer, and an NGO that coordinates and supports woman farmer groups in agricultural development. In the Solomon Islands: an NGO that promotes the strengthening of food security and sustainable livelihood development in isolated rural communities, and the Ministry of Agriculture and Livestock to coordinate project activities, reproduce machines developed by the project and facilitate farmer training in the use of the machines.

| Baseline surveys in selected communities in Papua New Guinea and the Solomon Islands. These comprised of farmer interviews and personal observations to elicit information on current farming practices and methods of mechanisation, and identify research needs, in particular on appropriate machinery for rice and peanut processing. |
| Design, development and piloting of prototype machines. The machines for rural farmers were designed and developed at the mini-engineering workshop and thermo-physical laboratory at NARI. The prototype machines were designed in a way where materials to building them, particularly the ‘Kisar’ rice mill and the peanut sheller, are readily available in the rural communities:
  - After development, including a pilot and field test assessments, the prototype machines of the manual rice mill and the manual multi-nut roaster were re-modified or dropped for not being economically or mechanically viable. Hence, the simple ‘Kisar’ manual rice mill, introduced from Indonesia, was subjected to rice milling tests.
  - The development of the peanut sheller was based on the design of the ‘Kisar’ rice mill and re-modified for shelling peanuts, followed by peanut shelling efficiency tests.
  - The solar rice dryer was developed and evaluated through tests on moisture reduction of rice at NARI and at the project sites in Papua New Guinea (the Highlands Agriculture College in Mt. Hagen in the Western Highlands province, and Madang in Madang province).
  - The performance of the prototype machines was assessed during piloting in farming communities at the project sites in Papua New Guinea.
  - Training-of-trainers through participatory approaches took place on the use and reproduction of the ‘Kisar’ rice mill, peanut sheller and solar dryer. |
| Economic assessment of the prototype machines by collecting data through questionnaires during demonstration of the machines at the project sites: Garam village in the Markham District in Morobe; Wasab and Karkum villages in the Sumkar District, and the DAL 2 station in Madang; and DAL station in the Eastern Highlands (Papua New Guinea). The survey included interactions with both rice and peanut farmers:
  - Rice solar dryer and ‘Kisar’ rice mill. A non-probability (purposeful sampling) technique was used to select samples which allowed only for farmer’s trialling the prototype machines to be interviewed.
  - Peanut sheller. A separate demonstration and interview were conducted for the assessment of the prototype peanut sheller at the Lae main market. This interview was conducted specifically with the peanut sellers who usually sell roasted peanuts.
  - Conventional drying and power mill. A probability sampling technique was applied using a simple random sampling method to select samples for assessment of this prototype. It was observed that all rice farmers use conventional drying, while only a few farmers have access to motorised rice mills (micro and bigger mills). Hence this method allowed equal representation of both the model and non-model farmers. Model farmers are progressive farmers or champions in rural communities, which were selected to partner in the project. |
Models
- Modified wooden ‘Kisar’ manual rice mill.
- Modified iron manual peanut sheller.
- Solar rice dryer.
- Winnower basket (developed in Asian countries and promoted to rice growers in Papua New Guinea).

Facilities
- 2 engineering workshops: at NARI (Papua New Guinea) and MAL (Solomon Islands).
- 1 thermo-physical laboratory at NARI (Papua New Guinea).

Capacity building
- 14 farmer training workshops (12 in Papua New Guinea, 2 in the Solomon Islands):
  - 57 Trainers-of-Trainers trained in the development and use of the peanut sheller.
  - 68% male and 32% female farmers.

Outputs

Networking
- Extensive networking with rice growers associations in Eastern Highlands, Madang and Morobe provinces (Papua New Guinea) and Isabel province (Solomon Islands).

Visibility
- 1 video on the ‘Kisar’ rice mill to raise awareness and adoption of the simple innovation in rice milling in rural rice growing communities.
- Print media, social media, TV, radio.
- Posters.
- Agriculture shows.
- T-shirts and mugs.

Documents
- Prototypes evaluation at Highlands Agriculture College (HAC), Kagamuga, Western Highlands Province, Papua New Guinea, April 2015 (NARI Technical Report).
- Smallholder use of farm machinery in communities in Papua New Guinea and Solomon Islands, 2016 (internal NARI report).

Publications
- Economic assessments on the prototype machines for rice milling and peanut shelling (NARI Internal Report; draft for journal publication).

Outcomes
- ‘Kisar’ rice mill adopted by 25 rice farmers throughout Papua New Guinea and peanut sheller by 2 peanut farmers in Morobe province.
- Farmer communities made aware of benefits of small-scale farm mechanisation.
- Enhanced technical skills for research technicians in Papua New Guinea and the Solomon Islands in the development of appropriate small-scale farm machines.
- Enhanced farmer learning on simple machine development.
RESULTS

Usage

Innovations in farm mechanisation have brought significant social changes in rural communities:

- Farmers in the Markham district, Morobe province (Papua New Guinea) are producing their own ‘Kisar’ rice mill using local construction materials: 15 ‘Kisar’ mills with 3 of them donated to 3 local governments for awareness raising and training.
- Farmers in the Markham district no longer transport rice to mills in Lae. Smallholder rice growing farmers who can save by 80% with less processing costs (transport, milling) will require less labour with the use of the ‘Kisar’ rice mill and increase household income through the sale of rice within farming communities.
- Farmers who owe a ‘Kisar’ rice mill can mill and cook for family consumption.
- Rice that is dried, to correct moisture content, can extend the food storage period.
- Farmers are re-training other farmers in ‘Kisar’ production in various communities in the Markham district and in Madang (Papua New Guinea).
- The use of wood for the construction of the ‘Kisar’ rice mill and the peanut sheller has led to community appreciation of forest conservation, particularly in Wasab village, Madang (Papua New Guinea).
- Improved networking between extension agencies and growers in Papua New Guinea.
- After a decline in rice production in Western and Isabel provinces (Solomon Islands), farmers are now growing rice again and milling using the ‘Kisar’ mill.

Policy implications

- Awareness has been created on the role of small-scale farm mechanisation in agricultural development in Papua New Guinea.
- Recommendations to the National Department of Agriculture and Livestock of Papua New Guinea for more focus on appropriate farm machinery to increase productivity for food security and household income.

Sustainability

- The participatory research approach will continue to bridge the gaps between research and farming communities – in view of the dysfunctional extension system in Papua New Guinea – and hence enhance the adoption and production of small-scale farm mechanisation tools.
- A new solar-derived rice milling innovation is currently being evaluated on a pilot scale in Morobe province (Papua New Guinea) for commercial rice processing.
- Institutionalisation of farm mechanisation at NARI: follow-up projects such as the solar water harvester (concluded in 2017) and the new solar rice mill.
- MAL in the Solomon Islands has recruited a research technician to reproduce machines and conduct farmer training.

TESTIMONIALS

Andrew Fei, Aronis village, Sumgilbar, Madang Province, Papua New Guinea

Andrew Fei is the model farmer who introduced the ‘Kisar’ rice mill from Indonesia. As a trainer, he trained other farmers. “I have used the ‘Kisar’ rice mill for almost 5 years now and with 10 bags of 50 kg rice, I was able to feed my family from this rice for almost 3 years. I used the ‘Kisar’ rice mill to mill just enough for the day, which has sustained me and my family. While other villagers ran out of food during drought, we have more than enough to eat. In addition, my children do not wait for me or their mother to mill rice; rather it is easy for them to mill their own rice and cook when they are hungry. We have to be self-reliant and the ‘Kisar’ rice mill contributes to self-reliance. Most of the motorised rice mills break down and need spare parts which are difficult to access and the ‘Kisar’ rice mill is the answer since farmers can make these mills from local resources.”

Jasper Kopiridin, Isabel province, Solomon Islands

“Rice was on the decline until the project assisted us to participate in the training workshop on the ‘Kisar’ rice mill. Now there is hope for us. Prior to this project and despite good rice harvests, and since Solomon Islands is a maritime country, it was costly and difficult for farmers and rice co-operatives to transport rice by boats to rice mills in nearby towns. This was the major constraint confronted by rice farmers in rice growing provinces. Our Ministry of Agriculture and Livestock purchased motorised rice mills, but when these machines broke down, we had problems repairing them or there were no spare parts to repair them. This has led to many rice farmers giving up rice production and rice production had been on the decline until the project came to our rescue.”

Doris Awian, Garam, Markham Valley, Morobe Province, Papua New Guinea

Doris Awian, a female rice farmer, showing rice winnowing after milling using the ‘Kisar’ mill at a ‘Kisar’ rice mill training at the Takom Community Resource Centre, Markham Valley, Morobe Province, Papua New Guinea (December 2015). “Travelling long distances to mill rice by local rice farmers in Markham district will be minimised thanks to the introduction of the ‘Kisar’ rice mill into the community. The ‘Kisar’ rice mill training comes at a crucial time when rice farmers have struggled over the years to get their rice to the nearest rice mill in the provincial capital Lae which is costly. The costs incurred include return transport costs, freight changes, and milling charges. We have now been equipped with skills to develop our own ‘Kisar’ mill and the winnower. This farm mechanisation training will translate into positive outcomes and enable us to reap the full benefits from our rice and peanut farms. Now we can grow and mill our own rice.”