AGRIMECH AFRICA Ltd is an expert on Modern Potato Farming:

Potato Farming and Potato Mechanization in Kenya:

The Potato (*Solanum Tuberosum*, also called the Irish Potato in Kenya), is one of the crops identified for advancement as a Food Security crop within the National Big-4 development agenda. As an alternative to maize crop, as the middle class and young population dominate the economy and as urbanization levels in the country rise drastically, the potato has become an increasingly important crop. The potato is being eyed as the crop to reduce the cost of food with production targeted to increasing potato volumes to 2.5MT per annum (Technoserve et al. 2018)

Potato pre-occupies the livelihoods of some 800,000 farm households. Potato can be labelled the smallholder farmer's crop in Kenya. Its production contributes KSh 30-40B per annum at retail level, but production has not grown since 2010 for various material and value-chain challenges. In Kenya, the potato can raise national GDP by 0.3% if 40 percent of farmers farming the crop would only double their yields. By doing so, the smallholder farmers would increase their profit by KSh 70,000 to 140,000 per year.

> In terms of smallholder farmer profitability, mechanization will reduce waste by 5-10% and increase yields by about 30%. The challenge of mechanizing smallholders is the fragmented nature of their small pieces of lands, some being located on unfriendly terrain. Under these circumstances, specialized business models are needed, not just for smallholder potato farmers but for all mechanization of agriculture in Kenya, like the rest of sub-Saharan Africa.

It has been reported (Technoserve et al. 2018) that the highest priority interventions for enhanced potato value-chain delivery should focus on seed and farmer groups, while encouraging business opportunities in processing, irrigation and mechanization. While several of these development aspects have clarity, have been advanced and have shown results, the one high-impact and missing intervention that requires the most urgent attention is mechanization.

The most urgent form of mechanization for potato in Kenya is for production. The value of this opportunity is estimated to be a Ksh 1 Billion per year for farmers and Ksh 1 Billion for Mechanization Service Providers (MSPs) even if only 10% of the sector is mechanized.

Potato Mechanization Interventions:

Potato mechanization needs interventions that address issues from 4 perspectives:

1. Technological and Economic Benefits of potato mechanization,
2. Financing opportunities,
3. Need for organizational development of Farm Based Organizations (FBOs) to receive structured mechanization services,

4. Importance of mechanization for volume and tuber quality delivered at the market.

Aspirations of the Potato Sector:

Aspirations of the potato sector in Kenya are captured in the plans of the National Potato Council of Kenya (NPCK). This sector-coordination body brings together the works of sector development supporters like international NGOs (GIZ, AGRA, IFDC, SNV etc.), farmers, their groups and cooperatives, farmer service providers and other stakeholders.

In 2017, NPCK reported it was aiming to raise potato yields from the current 8 tonnes/ha to 18 tonnes per ha and by doing so increase the number of targeted key farmer groups from 22 to 220 in 4 years. That movement was expected to raise the target crop area from 5,000 to 50,000 acres which translated to a rise in investment from Ksh 450 million to Ksh 4.5B and income to farmers of 748 million to 7.48 billion. This journey and ambition is still on, and it is facing various challenges.

NPCK has developed the *Viazi Soko* digital platform. The platform is supposed to make information flow, communication and business dealings easier for all value-chain practitioners. Through the *Viazi Soko* App, farmers can request for input services, and eventually this will include mechanization.

Potato Mechanization Perspectives:

The Case of Nyandarua:

- Nyandarua has 91,250 acres of potato land to be worked each year, of which, it is estimated there are some 400 tractors, of which some 70% of them are in fair condition (AMS Report).
- Most tractors available have only a plough. Only a few farmers have harrows and ridgers, which may mimic appropriate potato mechanization. Nyandarua Agricultural Mechanization Service Centre (AMS) has a set of modern potato machinery to introduce to farmers.

The

> ***It is Agrimech opinion that Government AMS centres should be training grounds for Mechanization Service Providers (MSPs) and their clients. Such Centres should work with companies like Agrimech, to organize Agrimech Mechanization Hubs, from where, credible, serviceable and fully supported mechanization services (in partnership with machinery vendors, operational supporters, financiers, and other members of crop and livestock value-chains) can be organized and managed.***

Nyandarua AMS is an example of the enabler role of Government in the enhanced mechanization agenda. However, like everywhere else in the country, Government should refrain from engaging in mechanization services and enable private sector to perform and build a profitable business.

Challenges and Solutions for Mechanization:

At a recent Mechanization Service Providers (MSPs) stakeholders event that Agrimech organized with the support of the Nutrition Sensitive Potato Production Programme (NuSePPP) of GIZ, participants raised the following challenges and thought-out solutions:

Challenge	**Associated Solution/Recommendation**
Land sizes are small and they continue to decrease as culture dictates. It is difficult to carry out crop rotation and mechanize highly limited land sizes.	Regulations and ***land policy*** against agricultural land sub-division needs to be enacted at County-level and nationally.
There is general ***lack of qualified tractor operators and mechanics***. Tractor drivers are not operators and while a tractor is the prime mover, it is the implement (planter, sprayer etc.) that does the work.	Government and others need to initiate a serious ***agricultural machinery operators programme***. It is a great way to absorb the huge unemployment among the youth.
Mechanizing smallholders finds unpredictable farm conditions. MSP must inspect the farm physically before service, which adds to ***service cost***.	- Stakeholders should liberally adjust ***MSP charges*** to meet the costs involved. - Government should ***subsidize*** smallholders' Service Providers.
Tractor ***operation is generally expensive*** and difficult in unfriendly work conditions. Youth may not find the work conducive.	- MSPs and Operators (old and young) need to be highly passionate machinery lovers, ***risk takers*** and committed to serving smallholders.
Tractors age quickly because of the lack of or ***expense of genuine spares***.	- MSPs need to ***train*** for and learn to appreciate the ***value*** of genuine spare parts. - Governments should consider ***removing duty on imported spare-parts*** like is the case for agricultural tractors.
Roaming tractors and implements are ***spreading soil and crop diseases*** between farms and regions.	Organized and trained service providers will voluntarily ***sanitize*** their ***equipment***, between farms.
Continued use of ***mouldboard or disc ploughs*** is bad for the soil and the environment.	Farmers with reasonably good tractors can be ***hirers of chisel ploughs*** and accompanying or subsequent implements from pools owned by County Government, an ***association of MSPs*** or a large MSP.
Smallholder farmer ***clientele is translocated*** and disorganized.	Farmers need ***group organizations*** to add efficiency to training and application of regulation, including the necessary ***bylaws***.
Effective ***mechanization with in-built crop rotation*** needs largescale farming. Smallholder farmers do not have the same.	***Land-use consolidation*** for smallholders is the solution that should be sought, via improved farmer and MSP organization.
MSPs are too ***disorganized and limited***, many with very old machinery, unable to	The example given of ***German Machinery Ring*** is the ultimate of MSP organization across the land. It is where Kenya should aim for the future.

play a role in current advancing and demanding operation arena.	
MSPs are ***many but with limited capacity***. This makes the MSP arena look like it has idle capacity. MSPs need improved capacity and to be coordinated and managed.	There is much credence in the ***formation of a mechanization hub*** from where machinery service providers can be coordinated and assigned work that is near them. This ***"UBER-nization" of services*** is the ultimate, even learning form the German Machinery Ring experience.
Banks are happy to use the Tractor Log-Book as ***Collateral***. The same is not possible for implements (because they are not Government-Registered assets)	- Financial institutions need to change their ***lending policy*** to agriculture. - Government should offer ***Credit Guarantee*** to MSPs
Serving smallholders is highly seasonal and ***time-windows*** for structured and coordinated services are easily influenced by ***changing climate and weather patterns***. Retaining operators on Commission payments is difficult. Clients seem to queue in the last minute.	- Organized and ***structured MSP pools*** are necessary so that Operators are busy, with many operations for longer (whole-season) periods of time. - Long queues at end of land preparation season can be avoided through ***farmer organization***. - Practice ***Conservation Agriculture***. - Permanent salary terms are possible through **MSP Associations**.
Serving smallholders can take 50% of the profit in ***transit costs***, between farms.	MSPs should work together to ***shorten travel distances.*** MSPs should ***work with produce aggregators*** to enhance, land-use consolidation
Small machinery for ***potato and other tuber farming is almost non-existent***. Potato farming requires large ridges and to plant potato at the top of the ridge. Most existing machinery is not able to deliver this.	- Aim for ***MSP potato services*** other than trying to purchase the expensive machinery for small farms. - Small machinery for potato farming may apply for a farmer who can afford their own, for their ***farm alone***.
Quality operations cost money. There is the metal (machinery) and there is the Know-how (knowledge). To a great extent smallholder clients do not know quality mechanized work.	- Mechanization clients need to be ***trained*** to pay for quality delivered. - Smallholders should aim to ***pay against the realized yield increase***, not just for machinery showing up.
Tractors and implements are expensive for farmers to own. Potato machinery can cost some 10 million shillings.	- ***Government subsidy*** to fertilizer should apply equally to agricultural mechanization. - Farmers should come together as ***groups*** to add efficiency to Government and other assistance.

To make business sense, MSPs are forced to ***roam the country***, say, from Nyandarua to Mpeketoni (in Lamu), some 900km. This keeps them away from home for some **9 months a year. Roaming** driver becomes the tractor owner, collapsing the business.	- Use tractor tracking and operational monitoring ***digital platform***. - There is urgent need to have a ***MSPs Association***. Through this, MSPs will be trained to perform more ***operations than ploughing***.
Even when fuel prices or other changes take place, farmers expect ***MSP prices to remain the same.***	Farmers need to ***be in groups***, through which mechanization changes can be trained and changes adopted.

Parameters that Determine Successful Mechanization Service Provision:

There are 5 key parameters that determine the entry point and service provision costs for MSPs:

Parameter	Agrimech Opinion based on Company Experience
Purchase of new or used equipment	Equipment is generally very expensive for farmers and acquiring it will almost always require external source of funds.
Fuel costs	These take-up at least 30% of the operational costs.
Labour costs	It is best to pay machinery operators on commission, however a few should be retained on permanent basis to take-on emergency and off-season assignments.
Service distance:	Travel from one farm to another is expensive unless there is adequate work that absorbs the travel upon arrival at destination. Overall tractor engines and tyres are sized for off-road operation and long distance travel on tarmac by road should be avoided.
Idle time of implements:	Downtime of implements is the greatest handicap of agricultural mechanization equipment. It is unlikely an MSP will avoid a level of roaming, across rainfall isohyets.

Mechanization Impacts on Potato Processing:

Improved mechanization performance at crop production level:

- Will help farmers adopt modern farming practices and raise their business standards, including the understanding of price differentials along the supply-chain.
- Will help increase operational volumes, hence scale for all players at all stages of the value-chain, including farmers.

- Will improve the volume and quality of raw material supply, making it worth the investment in storage facilities.
- Will encourage processing factories to invest in storage and improve their processing efficiency as improved potato varieties will come in the right size (50mm +) and unscathed, if not harvested mature.

Challenges and solutions at potato post-harvest level:

Post-Harvest Challenge	**Associated Solution/Recommendation**
Smallholder potato farmers are hard to work with under contract arrangement. Despite signing contracts they side-sell and expect the market or processor to understand.	- Farmers need to understand that their greatest role is to reduce costs of production or increase yields. - It is not always the role of the farm-gate purchaser to increase price.
Potato market Aggregators, Off-takers and Processors do not pay farmers enough, to be able to stay in business.	- The single most important factor of value-chain performance for potato, where all stakeholders can benefit in a win-win sense is "overall tonnages availed at the farm-gate. In this mechanization has a major role to play. Same land can double or even quadruple the yields and it is yields that have the greatest influence on price at farm-gate. - Value-chain volatility affects the entire chain and all parties. - Organized farmer groups are key to organized training, towards learning to distribute the price among all players in the value-chain, including MSPs.

Working with Partners

The SNV (Dutch Development Organization) Potato mechanization Showcases of Meru and Nyandarua County

{Here is a Synopsis of the SNV Collaborative Project Field-Day- Supported by Pictures}

The potato Showcase planted in Nyandarua showed farmers:

1. The viable performance of a clean and new Dutch Variety, (Destiny).
2. The impact of Conservation Agriculture where a reduced number of machinery operations, beginning with good subsoiling, bedding and planting, can lead to a crop that can survive and perform on a single rain storm.
3. What would cost some Ksh 60k per acre (ploughing, harrowing twice, manual ridging, manual planting, weeding and harvesting etc.) is doable at some Ksh 25k at 10% of the time and without hassles of labour management.

Potato Harvester at work. The machine operates below the planting depth to lift the soil and potato. It shakes off the soil and leaves potato in a line (windrow), for labourers to collect and bag. More sophisticated harvesters will bag or even convey clean potatoes to a truck travelling next to the harvester like happens in wheat harvesting.

Although the Showcase Demonstration of March 13, 2019 was geared towards training farmers about mechanized potato harvesting, the opportunity was taken to demonstrate the subsoiling, bedding and planting operations as well. The curiosity and interest derived from the farmers was palpable. Many asked questions of:

- Process and price
- Savings in labour and overall cost.
- Availability of machinery.
- Change of paradigm to plant on the ridge.
- How a crop had amazingly survived a drought season.

Bedding Operation: On a subsoiled or Chiseled soil, this machine with rotavation knives softens the soil and forms the ridges at the same time.

Upon this, fertilizer is spread and a planter follows, to plant the seed on the ridge and reform the ridges.

It is this placement of seed by the planter on a soft soil all round (and not at the hard bottom-of-ridge, where seed is placed traditionally), that makes the entire difference in yields.

Other good agricultural practices like soil testing, quality seed, moisture availability and crop-care, add to the impact derived from mechanizing potato farming.

Potato planter at work. Seed, preferably the size of a chicken-egg and adequately sprouted is conveyed, one at a time, to land about 30 cm apart (see bottom picture) and consistently so, with greatest of ease. The 2-row planter can easily do 8 acres in a day, especially working with two other tractors, one subsoiling and the other ridging.

Agrimech Business model is one to see how to have banks of equipment which Mechanization Service Providers (MSPs) can attach to their tractors, working in teams.

It takes a true paradigm shift for farmers to imagine that they can step aside and let machinery deliver harvested potatoes to their yards. This eliminates the expensive hassles of finding mechanization that will only plough and managing huge teams of labour providers at every stage. This situation, (like farmers repeated over and over again) is indeed discouraging the advancement of potato farming in the county.

Final condition of a planted field looks like this. Farmers could not believe that a field with potato crop already planted could look like this. At 3 inches after germination a Hiller-Weeder or Ridger would normally be brought in to ensure any rain-eroded soil is replaced around the potatoes, as the same single pass machine also does the weeding.

On the potato harvesting day participants were treated to a “free-show” of a Combine Harvester, harvesting an oat crop that had been planted with an air-seeder, next to the potato Showcase.

The field-day did not miss the importance of engaging youth to be exposed to and appreciate that agribusiness can be modern and effort-less if only mechanization can be made the affordable and the accessible means of transforming hard labour scene to a profitable and doable arena where professionals can thrive.

The event had several sellers and representatives of Agronomic Inputs for potato and more.

Students get introduced to Lemon-Grass by a Village Level Entrepreneur. In a Field-Day like this one which was called for Potato Harvesting Mechanization, it is amazing the exchange that took place between all manner of entrepreneurs and their potential future, if not current clients.

A seed propagator showed a new agronomic way of growing potato from a Crate Nursery.

A Lady-Farmer contributes at the Stakeholders Address and Discussion session that followed the Field Demonstrations of the day.

Speakers who were exhibitors were given a chance to talk about their technologies and exhibits as many a speaker linked their potentials to what potato and other agricultural mechanization can bring about.

As a way forward:

- Agrimech and SNV were challenged to make real the services of potato mechanization for farmers, *like yesterday*!
- County Government promised to sustain the services, to make Nyandarua the go-to County for agricultural and particularly potato mechanization.

The GIZ (*Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH*) Potato mechanization Showcases of Nyandarua County

Mechanizing Potato Farming (*Agrimech Collaboration with GIZ*)

Agrimech in partnership with GIZ NuSePP Project (on potato in Nyandarua County) has conducted Potato Value-Chain Investor Field-days with great success. Through these days, the place for mechanization and the huge savings that bring seasonal costs from about Ksh 95,000 to Ksh 35,000 have been appreciated. For example, farmers observed that what took some 50 workers to do all day in a potato harvesting operation took only 2 hours with a 2-row potato harvester.

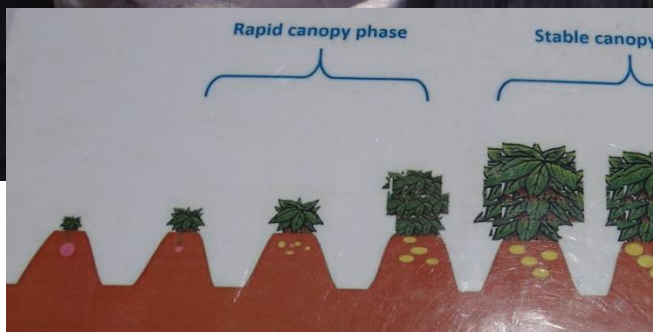
The Young and the Old, the Farmer and the MSP, the Machinery Seller, County Leaders and others, all came out to learn together… The greatest part of such days is what follows in terms of real mechanization service and change for the farmers… Farming does not have to be so difficult and dirty?!… Modern farming is cool and attractive to youth…

Farmers learn the "<u>Mechanization Way to Modern Farming</u>" and the place for specialized fertilisers... Potato farming is all about the size of the ridge the farmer is able to form. The easiest and most impactful for high yields is the one made so easily by the tractor… Mechanization will NOT create unemployment for our Labourers… It will release them to do more honourable and less tiring jobs with their very able hands… <u>What 20 labourers do in 4 days, can be done in one morning, planting potatoes with machinery… So, which is the better way? and why wait?</u>

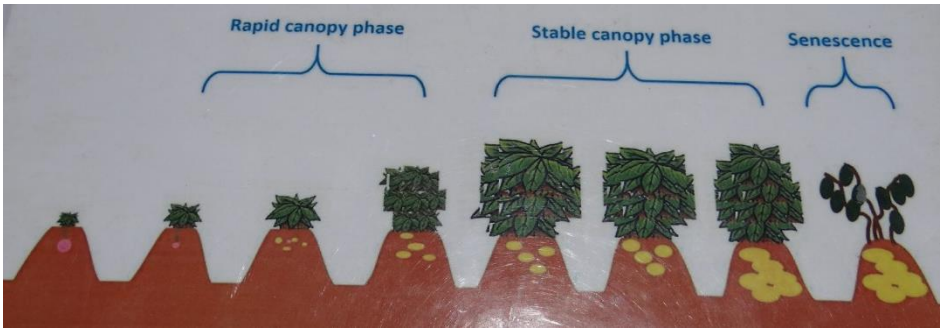
Farmers learnt of all manner of machinery and their specialized uses. Then they left wondering why they thought their Mechanization Service Provider (MSP) Kamau (in their village) was mechanized with only a plough and harrow for all crops…? The questions that kept coming up are, "How do I get these machines working on my farm!?" and "At what price?"… Development and progress is about getting good answers to these clever farmers' questions, among the many others that came in continuously!!


MASSEY FERGUSON

This picture is the Ultimate Demonstration of Modern, Mechanized Potato Farming. The Soil Ripper to the Right breaks all obstruction (Hard Pan) - to change soil into a Sponge Mattress, ready to receive and hold the upcoming rains. The resulting conditions are easily served with fertilizer by hand or from a Fertilizer Spreader (a Machine). The machine to the left, The Bedder, beats the soil on the Right to a soft texture, and forms ridges (or beds) in one pass. The resulting bed is ready for potato seed, to be placed by the next machine, with the same tractor. This potato is assured to thrive, come poor or harsh rains. This way, the Plough, Several Harrows, Ridger and Labour to plant are replaced, effectively and with results that are seen in terms of costs saved and yields that are doubled and even quadrupled, - simply from the way soil is prepared. ***This is Conservation Agriculture for a Tuber-Crop!***



Farmers learn from a Potato Seed Company the power and benefits of planting quality seed (THE RIGHT WAY, TO DERIVE MAXIMUM BEBEFITS) …That is AT THE TOP of the ridge. Not in the furrow, please (See picture to the Right)



Mechanizing Cereal farming


1


2


3


4

Depending on the final soil condition needed by the farmer, a plough with selated discs like in 1 and 2 can be used. F conservation Agriculture a Chiseling operation like in 3 can precede a refining and compacting pass like in 4.

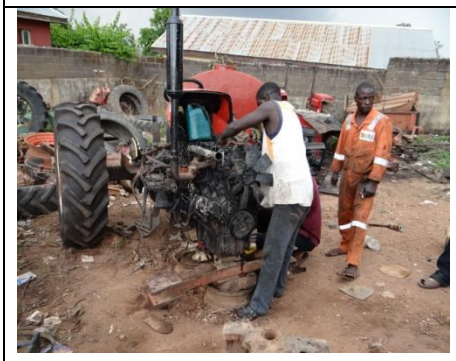
Special narrow wheelbase tractor for working between orchard trees. Special custom-made tractors like this one can be more expensive than a higher power and bigger size tractor.

Agrimech work on Potato across the Continent

Research Team Meeting with Government Officials of the Plateau Agriculture Development Programme (PADP). The team included the Programme manager as well as the Coordinator for the Potato Value Chain and the M&E leader in the State.

The team praised the work GIZ is doing in the state and raised value-chain infrastructure challenges like the coolers GIZ is addressing as critical. They mentioned that the Africa Development Bank is also out to address storage.

Asked about programme aspirations the team raised seed access and seed among other training, noting potato is a multi-sex crop. They reiterated availing basic mechanization will attract other mechanization easily and quickly. They stated that capacity for ASTC to mechanize has been curtailed by small land sizes.



From this... ...To this in 40 to 60 days

depending on initial condition and spares availability

The research team was greatly impressed by the ingenuity of a couple of brothers tractor service and repair shops. Their ingenuity at refurbishing 'expired' tractors locally was most impressive. A refurbished tractor may sell at 40 to 60% the price of a new one, depending on whether the refurbished unit belongs to the buyer. No guarantees but some gentlemen agreements work. Refurbished tractor may work for3 years in a new lease of life.

- Courtesy of Chief Obinedu of Emma Nigeria Ltd.

Team meeting with ASTC Snr Management. ASTC reported they have to take on input stocking and sales, dairy farming, among other business to stay afloat. Machinery hire services to smallholders cannot sustain the

	company. Frustrations include knowing there is a chemical cure somewhere for your crop or livestock and you cannot get it because it is not licensed in the country you are operating in.
	ASTC has simple as well as highly sophisticated farm machinery and equipment. They run a training programme with banners like shown to the left. Talking to farmers, some of whom have trained here informs that there is a huge gap between the nature of equipment and services offered and the nature of farming environment prevailing in the State. The gap has more down-to-earth private sector providers, best placed to fill. Plans by development supporters need to create demand for mechanization through workable, integrated and market-linked business models.