CIMMYT Smallholder’s Mechanization Strategy

Rabe Yahaya – Senior Mechanization Expert - CIM/GIZ/CIMMYT

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Presentation Content

- Rationale of mechanization and farm power
- Strategic mechanization approach for Africa (Ethiopia)
- Farmers & SPs perspective - business opportunity in Ethiopia
- Challenges & lessons learnt
Rationale & Farm Power
Rationale for mechanization

➢ Mechanization improves the quality of field operations (e.g. row planting, more precise plant population, seed and fertilizer placement, efficient utilization of soil moisture during planting window)

➢ Mechanization helps in timeliness of operation
  o especially important for planting where delays can have a serious negative impact on final crop yields
  o and for harvesting and threshing where there is labor shortage

➢ Reduced drudgery

➢ Increased labor productivity

➢ Increased agricultural productivity

Source: FAO, 2013d
Rationale for mechanization (contd.)

➢ Mechanization allows easier application of post-emergence operations such as weeding or spraying.

➢ Drastically saves time and labour compared with conventional crop establishment systems

➢ According to our assessment result, agricultural mechanization can significantly increase gross margin of farmers

➢ In general by introducing mechanization
   ❖ the reliance on draught animal power can be reduced
   ❖ agricultural productivity can be increased
   ❖ labor can be channeled towards other high-value adding activities and sectors.
Farm Power relies mostly on Human & Oxen

Percent of total sources of power for land preparation

Source: Own adaptation from FAO, 2006
Farm Power & other Barriers require a new Vision

Source: World Development Indicators, World Bank

Use of Any Improved AMTs' by Smallholder Farmers (%)

<table>
<thead>
<tr>
<th>Region</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigray</td>
<td>65.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Amhara</td>
<td>76.8</td>
<td>23.2</td>
</tr>
<tr>
<td>Oromia</td>
<td>51.4</td>
<td>48.6</td>
</tr>
<tr>
<td>SNPP</td>
<td>87.3</td>
<td>12.7</td>
</tr>
<tr>
<td>Total</td>
<td>69.5</td>
<td>30.5</td>
</tr>
</tbody>
</table>

4 main barriers have been limiting the growth of agricultural productivity, thus holding back Africa’s “Green Revolution”

1. Poor government policies
   - Low government spending on agriculture (5% vs. 14% Asia)
   - Lack of strategy and coordination at a national level

2. Land fragmentation and ownership issues
   - Widespread small farms (< 5 ha) with subsistence farming
   - Difficult access to larger land pieces for investors (e.g. administrative hurdles)

3. Low-quality infrastructure
   - Very low road density, 40 times lower than India in 1970
   - Lack of adequate overall finance systems
   - Expensive access to agro inputs and to markets

4. Inappropriate seeds and inputs
   - “Asian imported” varieties with low yields and slow development of adapted varieties
   - Risk of vulnerable monocultures (e.g., diseases)

...therefore a New Vision for Agriculture in Africa is needed!

Source: “Base line study report on agricultural mechanization use in selected regions of Ethiopia (MoANR, ATA, CDR, Nov. 2016)
Strategic Mechanization Approach
CIMMYT works throughout the developing world to improve livelihoods and foster more productive, sustainable maize and wheat farming. Through collaborative research, partnerships and training, CIMMYT targets the challenges of food insecurity and malnutrition, climate change and environmental degradation.

**MISSION**
Maize and wheat science for improved livelihoods

**VISION**
CIMMYT contributes to the development of a world with healthier and more prosperous people – free from the threat of global food crises – and with more resilient agri-food systems.
CIMMYT Mechanization Strategy

❖ Use mechanization to increase smallholder productivity and incomes at farm and beyond
❖ Use mechanization to eradicate hunger and rural poverty
❖ Use mechanization to increase national food production and security
❖ Use mechanization to make farmers more resilient to climate change
❖ Use mechanization for sustainable natural resources management & biodiversity
❖ Use mechanization for rural youth employment creation
❖ Use mechanization for rural industrialization
❖ Use mechanization to build up capacity of researchers, scientific staff, DAs, extension services, universities, etc. across the entire value chain
Our mechanization strategy is based on:

- Climate Smart Agriculture (CSA)
- Building up farmers resilience to climate change
- Sustainable Intensification
- Conservation & precision agriculture
- Research in 3D printing
- Research in using of drones in agriculture for smallholders
- Produce more with less
- Increase power availability and decrease it use
CIMMYT Mechanization Approach (contd.)

- Review literature on ag mechanization over decades and outline best fits findings for SM
- Document the failure reasons, correct, adapt, validate and scale
- Conduct research in line with Climate Smart Agriculture (CSA) that builds up farmers resilience to climate change
- Identify and analyze the potential of precision agriculture for sustainable intensification in Africa
- Initiate and adapt technologies that increase power availability at farm (AD, 2WT, 4WT, etc.) and beyond
- Conservation agriculture that underlines:
  - Direct row planting (no till)
  - Crop rotation
  - Crop residue on the soil
  - Strip tillage
- Conduct research in 3D printing in to build up the capacity of engineering in aftersales services
- Conduct research in the use of drones for fertilizer, pesticides/herbicides application and seeding
Strategic Approach - Key Activities in Ethiopia

- Adapting, testing, piloting and scaling 2 WT technologies for improving soil fertility (direct row planting) in SNPP, Oromia, Amhara and Tigray regions
- Testing of 2\textsuperscript{nd} generation of cereal planters
- Awareness/demand creation
- Training & mechanization curriculum development with the private vocational training centres
- On-farm demonstrations to generate evidence on crop performance and profitability under small mechanization technologies
- Establishing network of spare parts dealers in Oromia, Amhara and Tigray regions
- Investigating leasing scheme using created revolving fund
- Support initiatives for importing or local assembling/production of 2WT/4WT based technologies
- Promote inclusive market development (not necessarily linking farmers directly with importers or manufacturers but work with the range of businesses in the value chain)
- Customized to the needs of the target group, their context, and identified market opportunities.
- Market-based - with solutions offered by commercial actors on a profitable basis
- Conduct periodic needs assessment to identify the most impactful mechanized technology opportunities and identify the niche for each technology and region
Business Models

Import dealers in Addis

Agro-dealers in project area (spare part)

Repair & maintenance services - workshops

High potential for other SP’s to be created and linked with MFI using RF

Service providers

CIMMYT, - GIZ

- Select SP’s
- Train on technical & business
- Provide two-wheel tractors and supplements
- Monitor & follow up
- Cost share 20%
- Link with MFI
- Create awareness & demonstrations
- Provide service

MFI

MoU will be signed on procedures

- Lobby the private sectors for greater market integration
- Involve & encourage manufacturers to produce implements

Adwa Agriculture bureau

- Monitor & follow up performance of SP’s
- Demand creation using demonstration through FTC
- Link high potential SP’s with MFI to access loan
- Lobby the private sectors for greater market integration
- Involve & encourage manufacturers to produce implements
Business Models for scaling up

Manufacturers

Microfinance

Primary Cooperative

Service provider

Farmers: primary cooperative members

Seasonal loans

Transfer of funds

Equipment and spare parts

Cooperative Union

- Guarantee to micro finance
- Procurement of equipment and spare parts

Transfer of machinery
Commercialisation and Scaling Phases

- **Constraints identified**
  - Promotional campaigns
  - Private sector interest secured
  - R&D rapid prototyping with private sector actors
  - Co-creation of improved products
- **Opportunities identified**
  - Demonstrations
  - Investment from PSAs
  - Business Strategy formulated
  - Co-creation of improved products
- **Interventions proposed**
  - Trigger
  - Uptake
  - Early adoption of the technology
  - Sales and commercial results
- **Market Assessment**
  - Enterprise Performance
- **Create partnership and R&D**
  - Growth in ancillary service providers
- **Pilot & demo**
  - More PSAs enter the market
  - Higher level of investment
- **Commercialization**
  - Product diversification and new innovation

*Source: Adapted from IDE and World Bank*
Strategic Approach - Impact intervention map

End consumer/user

Service provider

Dealers

Machinery manufacturer / importer

Input suppliers/ machinery

Farmer/local community

Individual Service providers

Union/cooperative Service providers

Spare part shops

Local Dealers

Machinery manufacturers/ Assemblers

Machinery importers

Machinery parts suppliers

Financial service providers

NGOs/projects

Research and development (R&D)

Extension service

Enabling environment (laws, regulations, policy)
Strategic Approach - Impact Pathway

- Improve quality of field operations timeliness of operation
- Facilitate post-emergence operations such as weeding or spraying
- Reduce drudgery and drastically saves time.

Selam Awassa Technical and Vocational Training College

NGOs/Donors
- Research and development (R&D)
- Extension service
- Financial Services Inst.

Support service
Steps in Promoting SM (contd.)

Site selection

❖ Examine the potential for mechanization within specific agro-ecological areas – topography, soil types, land holdings, farming activities, etc.

❖ Comparative advantage of small-scale mechanization compared to conventional farming system

❖ Availability of support services (repair and maintenance workshops, mechanics, agro-dealers, manufacturers etc.)

❖ The capacity of farmers to pay for services

❖ Private sector partners - to drive the supply chain and scale up processes.
Identifying tasks to be mechanized

- Value chain analysis of major crop - identify constraint and opportunity on the chain

Selection of technologies and their cost-benefit analysis

- In line with technical criteria of suitability to the site – soils, topography, stoniness, rainfall pattern, costs, etc.

Sourcing of technologies

- Imports or locally manufactured
Steps in Promoting SM (contd.)

Appraisal of the market for small mechanization

❖ Identifying potential importer/manufacturers
❖ Identifying potential local dealers
❖ Identify potential service providers

Appraisal of hire service business models

❖ Technical, ownership, management aspects
Strategic Approach - 2nd Generation planter

(a) & (b) 2BFG seeder metering units replaced by imported seed metering unit.

(a) Modified 2BFG-6A seeder for teff crop in action at Machakel, Amhara region, (b) Maize trial farm in Gudeya Bila district, (c) Wheat trial farm planted in Adwa district (2017).
Strategic Approach - Training

- Technical & agribusiness aspects of small mechanization
- Youth groups and individual service providers
- Training of mechanics facilitated by Amio in October 2017
- Training of trainers in four regions of Ethiopia
Training of mechanics & SP at Melkassa (contd.)
Strategic Approach - Awareness creation

(a) Field day at Adwa woreda in Tigray region; (b) field day at Amanuel zuria woreda in Amhara region; (c) field day at Adwa woreda in Tigray region; and (d) field day at Amanuel zuria woreda in Amhara region.

Total – 79 (22 females) participants
Strategic Approach - Awareness creation (contd.)

- Awareness/demand creation: involving EIAR, MoANR, private sector e.g. Amio, site coordinators - promoting awareness on-farm demonstrations, field days, awareness campaigns where farmer or youths are gathered for other activities e.g. Abiye farm in Debre Markos

Field day at Machakel in Amhara region

Small mechanization awareness in Debre Birhan (25 October 2017)
## Strategic Approach - in Numbers

<table>
<thead>
<tr>
<th>Number of service providers and implements</th>
<th>Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015 &amp; 2016</td>
<td>2017</td>
</tr>
<tr>
<td>No of service providers</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>No of 2WT</td>
<td>19</td>
<td>40</td>
</tr>
<tr>
<td>Planter (wheat and Maize)</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>Water pump</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Harvester/reaper</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Thresher/sheller</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Trailer</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Number of people trained on 2 WT and different technologies <em>(including service providers)</em></td>
<td>35</td>
<td>402</td>
</tr>
</tbody>
</table>
Farmers & SPs Perspective - Business Opportunity
Currently promoted Technologies (innovations)

- 2 wheel tractor attached with seeder/for direct planting
- 2 wheel tractor with ploughing tool
- 2 wheel tractor mounted water pump
- Reaper / Harvester
- Maize seeder
- Sheller/thresher
Performance of planter

(a), (b), (c) and (d) teff crop establishment performance under modified 2BFG-6A rotary tillage seed drill at Melkassa Research Center, September 2017

(a) and (b) wheat planting performance of the 2BFG-6A rotary tillage seed drill at Machikel Woreda, Amhara region.

(a) and (b) show how the maize seeder does quite at Gudeyabila Woreda, Oromia region on a female farmer’s field and male farmer’s field.
Economic viability of small mechanization

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Seeder+ thresher+ trailer+ water pump</th>
<th>Thresher+ trailer+ water pump</th>
<th>Thresher + trailer</th>
<th>Trailer</th>
<th>Seeder, trailer, and water pump</th>
<th>Seeder, thresher and trailer</th>
<th>Seeder + trailer</th>
<th>Seeder + water pump</th>
<th>Seeder water pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV ($)</td>
<td>24,976</td>
<td>20,362</td>
<td>19,318</td>
<td>14,725</td>
<td>20,384</td>
<td>23,932</td>
<td>19,340</td>
<td>2,404</td>
<td>1,360</td>
</tr>
<tr>
<td>IRR (%)</td>
<td>62%</td>
<td>58%</td>
<td>59%</td>
<td>64%</td>
<td>67%</td>
<td>63%</td>
<td>70%</td>
<td>30%</td>
<td>26%</td>
</tr>
<tr>
<td>B/c ratio</td>
<td>1.66</td>
<td>1.66</td>
<td>1.69</td>
<td>1.72</td>
<td>1.69</td>
<td>1.69</td>
<td>1.73</td>
<td>1.25</td>
<td>1.22</td>
</tr>
<tr>
<td>Increase in cost (10%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV ($)</td>
<td>21,195</td>
<td>16,886</td>
<td>16,168</td>
<td>12,398</td>
<td>17,425</td>
<td>20,476</td>
<td>16,707</td>
<td>1,447</td>
<td>728</td>
</tr>
<tr>
<td>IRR (%)</td>
<td>52%</td>
<td>48%</td>
<td>49%</td>
<td>54%</td>
<td>57%</td>
<td>53%</td>
<td>59%</td>
<td>24%</td>
<td>21%</td>
</tr>
</tbody>
</table>
Economic viability of small mechanization

Gross Margin increase a result of Mechanization- Machakel - Amhara

<table>
<thead>
<tr>
<th>Item</th>
<th>Without Mechanization</th>
<th>With Mechanization</th>
<th>% change as a result of Mech.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of production</td>
<td>1400</td>
<td>1820</td>
<td>30%</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation, Planting and fertilizer application</td>
<td>240.5</td>
<td>85</td>
<td>-65%</td>
</tr>
<tr>
<td>Weeding</td>
<td>63</td>
<td>63</td>
<td>0%</td>
</tr>
<tr>
<td>Harvesting</td>
<td>64</td>
<td>30</td>
<td>-53%</td>
</tr>
<tr>
<td>Threshing</td>
<td>40</td>
<td>22</td>
<td>-45%</td>
</tr>
<tr>
<td>Transportation</td>
<td>13.0</td>
<td>7</td>
<td>-48%</td>
</tr>
<tr>
<td>Seed</td>
<td>113</td>
<td>113</td>
<td>0%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>145</td>
<td>145</td>
<td>0%</td>
</tr>
<tr>
<td>Misc.</td>
<td>20</td>
<td>20</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>698</strong></td>
<td><strong>484</strong></td>
<td><strong>-31%</strong></td>
</tr>
<tr>
<td><strong>Gross Margin</strong></td>
<td><strong>702</strong></td>
<td><strong>1336</strong></td>
<td><strong>90%</strong></td>
</tr>
</tbody>
</table>
## Economic viability of small mechanization

<table>
<thead>
<tr>
<th>Without Mechanization</th>
<th>With Mechanization</th>
<th>% increase as a result of Mechanization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield/ha (ton)</strong></td>
<td><strong>Value of prod ($)/ha</strong></td>
<td><strong>Total Variable cost/ha</strong></td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>660</td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>493</td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>517</td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>587</td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>626</td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>557</td>
</tr>
<tr>
<td>5.40</td>
<td>891</td>
<td>651</td>
</tr>
</tbody>
</table>
### Maize per ha. gross margins

<table>
<thead>
<tr>
<th>Item</th>
<th>Without mech.</th>
<th>With mech.</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of production</td>
<td>891</td>
<td>891</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Variable costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation, Planting and fertilizer application</td>
<td>219</td>
<td>85.5</td>
<td>-61%</td>
</tr>
<tr>
<td>Weeding</td>
<td>55</td>
<td>85</td>
<td>55%</td>
</tr>
<tr>
<td>Harvesting</td>
<td>120</td>
<td>120</td>
<td>0%</td>
</tr>
<tr>
<td>Threshing</td>
<td>87.5</td>
<td>23.8</td>
<td>-73%</td>
</tr>
<tr>
<td>Transportation</td>
<td>54.0</td>
<td>14.5</td>
<td>-73%</td>
</tr>
<tr>
<td>seed</td>
<td>16.5</td>
<td>16.5</td>
<td>0%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>80.5</td>
<td>80.5</td>
<td>0%</td>
</tr>
<tr>
<td>Misc.</td>
<td>27.5</td>
<td>27.5</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>660</td>
<td>453.3</td>
<td>-31%</td>
</tr>
<tr>
<td><strong>Gross Margin</strong></td>
<td>231</td>
<td>438</td>
<td>89%</td>
</tr>
</tbody>
</table>
# Wheat per ha. gross margins

<table>
<thead>
<tr>
<th>Item</th>
<th>Without mech.</th>
<th>With mech.</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of production</td>
<td>1365</td>
<td>1785</td>
<td>31%</td>
</tr>
<tr>
<td><strong>Variable costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation, Planting and fertilizer application</td>
<td>240.5</td>
<td>85.1</td>
<td>-65%</td>
</tr>
<tr>
<td>Weeding</td>
<td>63</td>
<td>93</td>
<td>48%</td>
</tr>
<tr>
<td>Harvesting</td>
<td>32</td>
<td>32</td>
<td>0%</td>
</tr>
<tr>
<td>Threshing</td>
<td>40</td>
<td>21.9</td>
<td>-45%</td>
</tr>
<tr>
<td>Transport to homestead</td>
<td>13.0</td>
<td>6.7</td>
<td>-48%</td>
</tr>
<tr>
<td>seed</td>
<td>112.5</td>
<td>112.5</td>
<td>0%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>145.25</td>
<td>145.25</td>
<td>0%</td>
</tr>
<tr>
<td>Misc.</td>
<td>19.5</td>
<td>25.5</td>
<td>31%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>666</strong></td>
<td><strong>522</strong></td>
<td><strong>-22%</strong></td>
</tr>
<tr>
<td><strong>Gross Margin</strong></td>
<td><strong>699</strong></td>
<td><strong>1263</strong></td>
<td><strong>81%</strong></td>
</tr>
</tbody>
</table>
Challenges and Lessons
Challenges of Mechanization in Ethiopia

❖ Research and Technology Development
➢ Limited information on the agricultural mechanization needs in the country
➢ Limited resources allocated to agricultural mechanization research and development

❖ Manufacturing and import
➢ Infant domestic manufacturing sector
➢ Lack of machinery standards and testing
➢ High import tariffs (which drive up the cost of agricultural machinery)

❖ Distribution
➢ Lack of efficient and effective distribution models for agricultural technologies
Challenges of Mechanization in Ethiopia (contd.)

❖ Promotion, Purchase and Usage
  ➢ Limited awareness of mechanization among farmers and other potential users
  ➢ Lack of financial services to facilitate the use of mechanization services
  ➢ Weak institutional capacity for promoting mechanization

❖ After sales services
  ➢ Lack of available spare parts and after-sales services
  ➢ Poor aftersales infrastructure in rural areas
Lessons learnt

❖ Dynamics of mechanization: *entry points for expansion of scope and diversification*

❖ Flexibility: *re crops, machines, farmers, and locations despite the lead mandate CIMMYT.*

❖ Market development: *design of subsidies aimed at creating a virtuous cycle of market demand amongst the supply chain stakeholders.*

❖ Select countries where there is potential for market development and a clear current demand for mechanization technologies.

❖ Intervene in countries and locations where a positive momentum already exists.
Lessons learnt (contd.)

- Understanding farmers’ needs and capacity: *there tends to be an emphasis on the supply push but it is necessary to ask what farmers need*

- Support demand and supply creation simultaneously

- Develop business models from actors already in related business

- Market linkage, in particular with financial institutions - guarantee fund??

- Risk is a more important consideration than is usually expected. SP and user time horizons are short and related to prospective financial returns

- Raise awareness of enabling environment constraints (e.g. licensing and import duty) and advocate for the development of small mechanization.
Lessons learnt (contd.)

- It can be difficult to start the commercialization process with poorer and more vulnerable smallholders and it might sometimes be more effective to work outside of the zone of influence to eventually have an impact on the target population once the innovation goes to scale.

- Partner with private sector companies from the start; insist on a largely co-equal relationship where partners share risk and make a financial co-investment.

- Start with one or two key private sector partners interested in being first movers to create proper signals and incentives and to deepen and broaden the market.

- Subsidies and the public sector are important and often play a significant role in commercialization, even when promoted through commercial pathways.
Lessons learnt (contd.)

❖ Encourage domestic manufacturing and assembly of equipment - Joint-venture partnerships with foreign companies.

❖ Provide business services on a regular and continuous basis to support prospective machinery buyers with economic and financial advice

❖ Implementation for business development conducted by partner organizations with market oriented experience and capacity, but CIMMYT has a role in monitoring the work of implementation partners and providing technical support to them.
Criteria used for site selection

- Availability of mechanics, local repair workshops and finance institutions
- Availability and affordability of fuel
- Relatively commercially-oriented agriculture (e.g., presence of cash crops)
- Agriculture constrained by labour shortages, at least seasonally
- High cost of maintaining draught animals (e.g., feed shortage)
- Field accessibility (e.g., feeder roads)
- Existence of hire services (e.g., ox ploughing)
- Relatively deep and stone-free soils
Criteria for selection of SPs

The most effective criteria for the selection of SPs are:

- Previous experience in the shelling business
- Youth with no alternative sources of income
- People with an entrepreneurial personality, prepared to move out of their village or district to seek new business opportunities
- Experience in maintaining and repairing similar technologies
- Some formal education and discipline to keep records and use them to analyse business performance
Thank you for your interest!