Final Site Report for Tamul (Alkena and Kiripia) pilot sites
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1. Project Site Description

Alkena and Kiripia are two ethnic communities in the Tambul/Nebilyer (5.9250° S, 144.0110° E) district of the WHP. The altitude in Tambul/Nebilyer varies from 800 m in the lower Kaguel Valley to over 4,000 m on the upper slopes of Mt. Giluwe. Yearly rainfall is around 2,300 mm to 4,000 mm with an average temperature range of 18-20 °C while humidity ranges vary from 65-75 %. The staple sweet potato (*Ipomoea batatas* L.) is mainly grown for consumption whilst the Irish potato (*Solanum tuberosum*) crop and vegetables such as broccoli (*Brassica oleracea italica*) and cauliflower (*Brassica oleracea capitata)* are main income earners for most of the population. Livestock such as pigs, poultry, fish, goats and few cattle are also raised for both customary obligations and income or for own consumption (Hansen *et al*., 2001). Farmers from these two communities are part of the 15 % of PNG's population that inhabit the upper highland areas (>2,000 masl). With the threats imposed by climate change, farming communities in the high altitude areas are becoming more susceptible to frost, drought and excessive soil moisture conditions. People are vulnerable to excessive soil water and frost damage during prolonged wet and dry periods respectively (Hansen *et al*., 2001). This compels a major threat to food security especially with challenges to cultivation of the staple sweet potato. Sweet potato, is grown for both human and livestock consumption, playing a central role in high altitude semi-subsistence farming systems.

2. Site selection and Prioritization

The two communities were selected due to their vulnerability to frost, drought and excessive soil moisture conditions imposed by the changing climate. Through this project, proven agricultural technologies and improved farming practices were introduced as interventions into high altitude farming systems to improve resilience to threats imposed by the changing climate. These interventions were identified and prioritized based on farmer preferences captured via a needs assessment survey conducted in Alkena and Kiripia. Table 1 shows the initial SWOT analysis for the site.

Table 1. Tambul site SWOT analysis

Strengths:	**Weaknesses:**
• Access to land • No crop and livestock with significant cultural importance to prevents use • Interested and willing to try new things because they realized that there are problems in yield etc • SP system is a good working system that caters for all their need • More enterprise oriented (selling livestock, buying feed) • Availability of family labour • Able to maintain their own planting material (seed-system) • Use of sequential harvesting to prolong availability of SP (construction of mounds) • Aware of effects of climate change • Heavy rains but soil dries up quickly • No water shortage	• Land shortage • Use of same piece of land, less slash and burn; decline in soil fertility • Only one major staple crop used for food, sale, livestock, social obligations • Excess water (heavy rainfall) • Not enough water during dry season, poor quality • Water quality issues – Humans and animals use the same water source • Soil erosion close to rivers and creeks • Pest and Diseases (esp SP weevil, scab, viruses, taro beetle); no action taken • Only use of own planting material and • from within the community (no access to improved technologies) • Rely on store goods to bridge periods of food shortage; • Tuber rotting – Combination of saturated soils after heavy rainfall and following high solar radiation

Opportunities:	Threats:
• Bring in new crop varieties • Introduce new species • Introduce soil improvement and soil conservation practices • Improved drainage and mounds • Introduction of inland aquaculture • Improving livestock production (focus pig, chicken) • Options for improvement through use of long term stored feed • Intensification by increasing productivity from enhanced use of available land and financial resources • Improved water management –Multiple Use System • Improved water supply • Introduction of simple water purification techniques • Improving available cash income opportunities (potatoes, pig and broiler production...) • Farmers enterprise oriented	• Increased livestock production may affect already poor water supply and quality • More irregular weather patterns • Longer dry season • High population increase (land shortage, cultivation in vulnerable landscapes) • HIV/AIDS • Increased disease pressure in livestock when numbers increase

In a first of its kind project for the National Agricultural Research Institute (NARI), community members were engaged in a reporting back workshop. Each community member was invited to participate in the prioritization of the major constraint in their area and wished to do something about it (Table 2). Only the top three to five priorities were considered for addressing by the project. These constraints were later converted to project outcomes and prioritized based on their needs and understanding of the concept. Both gender had a fair representation in the workshop.

Table 2. Results of a voting exercise options addressing agricultural production constraints and opportunities at the workshop at Tambul pilot sites (Keripia and Alkena)

Options voted on in Kiripia	Voters (Kiripia)		
	Women	**Men**	**Both**
1. Producing more Kau Kau from the same piece of land	7	23	30
2. Introduction of new crops or new varieties of other crops	5	29	34
3. Making better use of Kau Kau through processing into livestock feed	3	12	15
4. Increasing production of pig and chicken for food and income	3	29	32
5. Increasing production of sheep and goats for food and cash income	0	6	6
6. Increasing fish and duck production for food and cash income	0	11	11
7. Improved mound system and drainage for increasing Kau Kau production	1	0	1
8. Protecting and improving soil on my plot	4	1	5
9. Protecting our water	0	1	1
10. Soil and water conservation to manage moisture stress during the dry season	1	2	3
Total votes	**24**	**114**	**138**
No. farmers	**8**	**38**	**42**

Options voted on in Alkena	Voters (Alkena)		
	Women	**Men**	**Both**

1. Producing more Kau Kau from the same piece of land	9	20	29
2. Introduction of new crops or new varieties of other crops in my farming system	12	47	59
3. Making better use of Kau Kau through processing into livestock feed	25	51	76
4. Increasing production of pig and chicken for food and income	27	61	88
5. Increasing production of sheep and goats for food and cash income	0	7	7
6. Increasing fish and duck production for food and cash income	13	23	36
7. Improved mound system and drainage for increasing Kau Kau production	0	11	11
8. Protecting and improving soil on my plot.	15	0	15
9. Protecting our water	0	2	2
10. Soil and water conservation to manage moisture stress during the dry season	0	10	10
11. Soil and water conservation to manage excess moisture during the wet season	0	2	2
Total votes	**101**	**232**	**333**
No. farmers	**34**	**77**	**111**

The interventions that followed involved farmer trainings, farmer-field-days and on-farm demonstrations of prioritized agricultural technologies and farming practices for crop and livestock production. These farming technologies were developed by NARI, in collaboration with relevant partner organizations, through continuous research and development efforts.

3. Interventions implemented at the site and summary of achievements

The implementation process involved an Adaptive Participatory Research Approach (APRA) (Figure 1) for both the crop and livestock components. Farmers within each community were selected and trained via specific selection criterions that more or less differ according to component and in each prioritized interventions. Farming equipment, livestock (ducks, chickens and fish), stock feed, seeds and other materials required were then distributed to farmers and on-farm demonstration trials using prioritized technologies conducted. The implementation and dissemination processes were refined through farmer views and responses gauged from farmer and community feedback assessments.

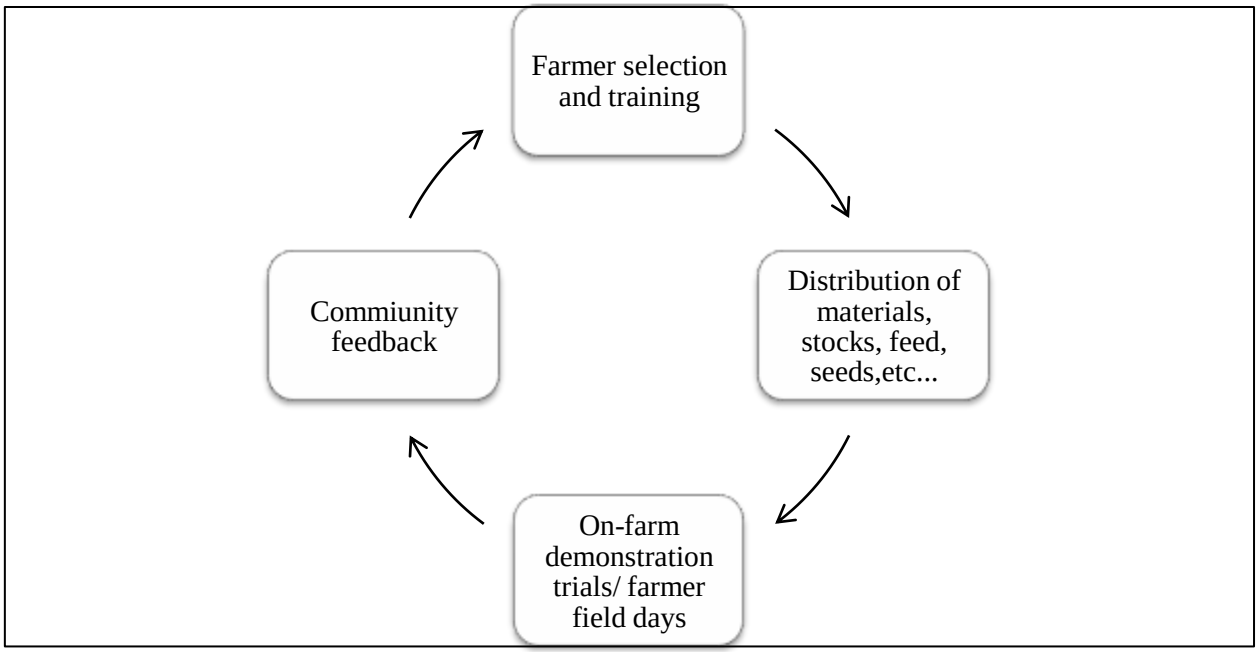

Figure 1 Shows a schematic diagram of the implementation cycle of project activities in the two Tambul sites.

The community feedbacks and constant farmer interactions proved crucial in streamlining the dissemination approaches so as to adequately respond to farmer needs. However there is still much to be done in terms of measuring the effectiveness of the dissemination approaches in each of the priority interventions implemented.

Table 3 shows an overview of outputs achieved and participation of different community members in relevant learning workshops and demonstrations that were conducted in Tambul communities. There were usually a number of learning events conducted per output and some community members chose to participate in only one of the events while others participated in all events for that output.

Table 3. The various outputs and participation of community members in relevant technology demonstration and learning events at Tambul Pilot sites.

Output	Description of output/ intervention	Farmers trained	Model farmers	Trials implemented
O1	Capacity for growing potatoes using improved locally acceptable production practices and PLB resistant varieties	22	8	8
O2	Farmer-preferred cold tolerant maize varieties identified and made available	40	6	6
O3	Capacity for growing wheat using improved locally acceptable production practices	20	5	5
O4	Cold tolerant rice varieties suitable for Tambul conditions identified	[Activity discontinued]		
O5(a)	Increased capacity for using improved pig feeding and management practices based on sweet potato (SP) as feed	163	23	15
O5(b)	Increased capacity for using improved chicken feeding and management practices based on SP as feed	56	23	23
O6	Increased capacity for using integrated livestock farming practices for inland fish and duck production	34	22	22
O7	Farmer-preferred excess moisture tolerant SP varieties identified and made available	85	6	6
O8	Increased capacity of farmers to use improved soil fertility management practices in SP production	38	16	22

There were some highlights (Table 1) on the priority interventions implemented through the project in Alkena and Kiripia. Though some technologies proved to be successful, others such as maize did not receive much attention as anticipated. The underlying reasons are still unclear but could be attributed to the each farmer's own perceptions and priorities in using a particular technology.

Table 1 Shows few highlights on some of the technologies disseminated as part of project interventions in Tambul.

Output	Description of intervention	Tech./farming practice	Farmer impressions
O1	Capacity for growing potatoes using improved locally acceptable production practices and PLB resistant varieties	Using PLB resistant varieties and improved management practices	• Farmers observed crop resistance to PLB and other morphological features during flowering stage. • Farmers observed increased potato tuber yield • Farmers observed reduced cost of growing PLB tolerant irish potato varieties compared to sequoia which is expensive
O2	Farmer-preferred cold tolerant maize varieties identified and made available	Cold tolerant maize varieties	• Though maize varieties introduced were affected by frost farmers were still interested to grow maize but expressed concern regarding seed supply.
O3	Capacity for growing wheat using improved locally acceptable production practice	Frost tolerant wheat varieties	• Wheat is one of the crop that is tolerant to frost and it withstood the impact of recent frost • Farmers learnt that wheat is one of the potential crops that can be grown to address food security and provide food period during and after frost experienced as in 2015.
O5(a)	Increased capacity for using improved pig feeding and management practices based on SP	SP ensiling and concentrate technologies	• Improved growth performance of growing pigs compared to those under conventional system • Improved quality of SP as feed for pigs

			• Observed ensiled SP as a means of storage over longer periods
O5(b)	Increased capacity for using improved chicken feeding and management practices based on SP	Concentrate technologies	• Observed significant cost savings of 15-20 % in raising broiler chickens [NARI concentrate + SP] • Produced table-eggs for consumption and income
O6	Increased capacity for using integrated livestock farming practices for inland fish and duck production	Duck-fish integration farming practice	• Observed improved growth performance and general body conformation of Tilapia fish and Muscovy ducks • Farmers were able to sell fish/ducks for income
O7	Farmer-preferred excess moisture tolerant SP varieties identified and made available	Moisture tolerant SP varieties	• Improved productivity through improve soil fertility management practices in SP production [increased marketable tuber yield]
O8	Increased capacity of farmers to use improved soil fertility management practices in SP production	Composting in SP mounds	

Some farmers were observed to be leaning more towards technologies that will generate more income while others were more concerned with food security for their families. A few farmers were only keen in trying out the new concepts promoted through the project. However there is still very high interest in most of the technologies disseminated and most community members have expressed their desire for the project period to be extended as well as expanded to other communities also vulnerable to climate change imposed hazards. Table 5 shows some additional information on the performance of some of the technologies compared to farmers traditional technologies and practices.

Table 5. Some highlights of the technologies implemented based on on-farm demonstration trial results.

Output	Description of output/ intervention	Conventional system yield	Intervention yield	Improvement
O1	Capacity for growing potatoes using improved locally acceptable production practices and PLB resistant varieties	Seeds weight used for multiplication: 0.24t (95net bags)	0.83t produced from 0.5 ha and distributed to farmers	71.2 % produced and distributed to the farmers.
		Production cost for sequoia Var. at 0.5 ha is PGK5366.00[1].	Production cost for CIP clones at 0.5 ha is PGK 4113.00. This cost is without fungicides application	CIP clones reduced 23 % of production cost compare to sequoia
O2	Farmer-preferred cold tolerant maize varieties identified and made available	Yield in kg/ha: 0t/ha No record at initial stage	Yield in kg/ha: 0.128t/ha	Yield increase:0.128t/ha
O3	Capacity for growing wheat using improved locally acceptable production practices	Yield in kg/ha:5.25-24.5t/ha	Yield in kg/ha: 27t/-72t/ha	Yield increase:22.0 - 48t/ha
O5 **(**a)	Increased capacity for using improved pig feeding and management practices based on sweet potato (SP) as feed	Average live weight gains of 65g per day	Average live weight gains of 160 g per day	146 % improvement in growth rates
O5 **(**b)	Increased capacity for using improved chicken feeding and management practices based on SP as feed	Live weight/bird:2.7 kg Profit margin/bird: PGK[2]20.85	Live weight/bird:2.8 kg Profit margin/bird: PGK 23.00	Weight difference:3.57% Profit increase:10.31 %
		Egg/bird/day:3 Cost/egg: PGK 0.89	Egg/bird/day:3 Cost/egg: PGK 0.74	Difference: 0 % Profit increase:16.85 %
O6	Increased capacity for using integrated livestock farming practices for inland fish and duck production	SGR[3]/ day in 127 days: 18.96 % Average Biomass :366 g	SGR/ day in 127 days:28.79 % Average Biomass: 2129 g	SGR increase: 9.83 % Average Biomass: 1763 g gained from each intervention pond
O7	Farmer-preferred excess moisture tolerant SP varieties identified and made available	Yield in kg/ha:2.4-22t/ha	Yield in kg/ha:3.4t/ha- 16t/ha	Yield increase: 1.0—9t/ha
O8	Increased capacity of farmers to use improved soil fertility management practices in SP production	Yield in kg/ha:2.4-22t/ha	Yield in kg/ha: Significant Increase in yield	Yield increase:Significant yield increase noted. yet to analyse data

[1] Costs inclusive of fungicides and spraying
[2] PGK is Papua New Guinea's currency the Kina.
[3] SGR is Specific Growth Rate for Tilapia

4. Challenges during Project Implementation.

Though the technologies implemented as part of interventions have being proven to be successful on-station these were at times difficult to prove on-farm due to the low literacy level of farmers. The arrival of drought and frost towards the back end of the project period has severely affected the availability of sweet potato and has made it impossible to feed poultry with sweet potato thus other possibilities in using cassava was considered. However the use of feeding livestock with root and tuber crops remains to be both a challenge and an opportunity in producing livestock feed through the Mini-Feed Mill concepts. Sweet potato, Irish potato and maize were severely affected whilst most wheat varieties being evaluated on-station withstood frost conditions and these could also be further screened for frost tolerance. Often planned activities had to be deferred in such cases as well as other instances when there are deaths within selected communities.

Table 6 Some challenges faced during implementation of interventions.

Challenge	**Effect on interventions**	**Approach taken**
Road blockages and deteriorating road conditions	Delay in implementation of planned activities	Stocking up of feed (concentrates) Defer planned activities to a suitable date
Drought	Drying up of fish-ponds in integrated facilities	Use alternate water source (where applicable)
Frost	Damage to sweet potato, potato and maize	Alternate feed options for livestock Replant crops when conditions are suitable
Death in the project sites [*Haus krai*]	Delay of planned activities	Defer planned activities to a suitable date
Farmer illiteracy	Understanding the technical aspects of the interventions	Using simplified TokPisin and pictures in explanations/Trainings, etc… Using model farmers with some educational background and experiences to explain difficult concepts in local language
Lack of district extension services	Closer monitoring and evaluation of demonstration trials	Timely follow up visit to farmer fields Use of mobile communications

Constant evaluation of dissemination approaches; feedbacks from technology dissemination procedures and studies on technology adoption are invaluable for refining dissemination approaches and success in technology transfer and are areas that can be explored by social researchers. Collaborative efforts between research and extension bodies are vital for widespread and effective diffusion of agricultural technologies and strengthening research and extension linkages which is currently a constraint in the project and project sites.

5. Final Assessments and Comments

The interest in all the interventions introduced remains to be very high in the two communities. The onset of drought and frost has affected many of the interventions especially sweet potato, potato, maize and livestock interventions that involved feeding pigs and poultry with sweet potato. Most fish ponds also dried up within that period. This has made the communities to realise the importance of water, diversifying agricultural activities and growing frost tolerant crops such as wheat. The communities have become aware of the effects of climate change and the strategies to at least cushion its effects. Since agriculture is the mainstay for most people in the two communities the prioritized interventions had proven beneficial but further support is needed from the government to help farmers recover and continue with the interventions after frost. Most seeds and crops have succumbed to frost therefore there is a need to redistribute seeds and planting materials to the affected communities. The supply and accessibility of farmers to source poultry concentrates still remains a challenge.

Final site assessments at Tambul pilot sites took place in November 2015. The following Tables 7 -10 show a summary of responses on technology performance and responses of representative farmers during focus group discussions.

Table 7: Technology performance in Alkena Community as assessed by representative community members

Technology	**Performance** **-Better** **-Same** **-Poor**	**Area Cultivated (for crops)**			**Do they plan to continue in the future (livestock)?** **-Yes** **-No**	**General Interest from the community-** **High (H)** **Medium (M)** **Low (L)** **Give Reason**	**Engage in Market. If Yes, What is the price?**
		Old practice	**New Practice**	**Plan to Expand, If yes by how many**			
Improved production practices for potato and PLB resistant varieties	Better,	Less than ≈1 ha	Establish after research - ≈10, 000, operating for commercial purpose	1ha+		High- less labor input, performs similar to previous variety introduced	≈K4000
Improved production practices for wheat Farmer selected wheat varieties	Medium	162 m^2		60-70 + m^2. But no further production (need milling machine to continue cultivation)			
Excess moisture tolerant sweet potato varieties	Better	≈ 180 m^2	≈24 m^2	180 + m^2 Frost damaged most SP vines slowed down garden expansion			
Improved pig/chicken feeding practices with sweet potato	Better				Yes	Chickens and pigs performed extremely well under the introduced feed and management system	Chickens K30 Pig- were not sold
Inland fish and duck integration	Better				Yes		Ducks-K20-K50
Improved soil fertility management practices for sweet potato	Better, SP improved performance						

Table 8: Responses from Focus Group at Alkena during final assessment on food production and priorities

Periods of Food Shortage	• June – August, November to December is experienced usually due to the excess moisture.
Views on whether improved technologies would improved food shortage period	• Given the frost negative impact which affected the SP potato which is the staple crop for both animal and livestock, has really confused whether the food shortage period can be solved using the intervention introduced or not. • However, regardless of the confusion, farmers mentioned if they continuously do what they were told, they will be able to store enough feed for pigs, poultry or make money to cater for the food shortage period. • Farmers also mentioned that wheat is one of the grain crops that can be used to help in the times when frost is experienced. Wheat is one of the crop that can withstand the damaging effect of frost and able to provide food for the farmers in the community.
5 Years ago, communities voted on certain priorities. Do these still remain important or have now changed?	• Reflecting back on the interventions voted and has been implemented farmers mentioned that those interventions are important to the community of Alkena. • However, given the effect of climate change causing prolonged drought and also frost phenomena, many of the respective interventions under crops and livestock were badly affected. • In the drought condition, farmers realize that, water is now an important need for almost all operations like for fish, pig, human and irrigating for crops. Therefore, almost all farmers agreed that water should have been voted as their number one priority.

Table 9: Technology performance in Kiripia Community as assessed by representative community members

Technology	**Performance -Better -Same -Poor**	**Area Cultivated (for crops)**			**Do they plan to continue in the future (livestock)? -Yes -No**	**General Interest from the community- High (H) Medium (M) Low (L) Give Reason**	**Engage in Market. If Yes, What is the price?**
		Old practice	**New Practice**	**Plan to Expand, If yes by how many**			
Improved production practices for potato and PLB resistant varieties	Better	≈162 m^2	≈162 m^2	Yes, 162 m^2+ but seeds destroyed from frost		High, CIP clones performed better without labor input required	Not sold,
Improved production practices for wheat Farmer selected wheat varieties	Better	Previously not planted	≈100 m^2	Yes, 100 + , but need mill		Medium-High, Given the there is need for milling machine increase interest, wheat withstood the frost damaging impact	Not sold,

Cold tolerant maize varieties,	Same	≈162 m^2	≈162 m^2	≈162 m^2		Low-Medium, the varieties perform similar to local ones.	Not marketed
Excess moisture tolerant sweet potato varieties	Better	≈162 m^2	≈100 m^2	≈162+ m^2		High, Improved marketable tubers, more number of tubers	Own consumption
Improved pig/chicken (broiler/layer) feeding practices with sweet potato	Better				Yes	High, improved growth rate and better performance,	Eggs marketed K1.00/egg Chickens-K30 Pigs not marketed, drought affected production
Inland fish and duck integration	Better				Yes	High, Farmers expressed interest to continue	Ducks-K15,
Improved soil fertility management practices for sweet potato	Better				Yes	Medium, need more dissemination to create interest	

Table 8: Responses from Focus Group at Alkena during final assessment on food production and priorities

Periods of Food Shortage	• During the initial baseline survey, community members mentioned that, food shortage is usually experience in the months of **June-August and Nov-Dec**, • However, when ask during the final EU-ARD assessment, it was mentioned that given the El-Nino induced drought and frost, they were not able to confidently confirm the duration of food shortage.
Views on whether improved technologies would improved food shortage period	• Farmers mentioned that the interventions introduced were better and were able to be used to provide food and also generate income to cater for the times of food shortage as experienced.. • However, given the El Nino, induced drought and frost had damaged most of the crops and also livestock. • However, many farmers expressed the sentiment that given the interventions and the skills learnt; farmers can now learn to think of different ways to make food available for both animal and humans during the food shortage periods and also cater for such phenomena as the El Nino induced drought and frost damages. • Since wheat can withstand frost, farmers mentioned that there is need for a milling machine to encourage farmers to continue wheat production within their established gardens.
5 Years ago, communities voted on certain priorities. Do these still remain important or have now changed?	• Farmers mentioned that the interventions voted and implemented were and are still important. However, given the El Nino, induced drought and frost phenomena, farmers realized that water is important to maintain crops production and also supply water to both animals and human for consumption. • If they had to vote again, water would be selected as their number one priority as most of the village lived

	along the mountain ranges and access to water for to livestock, own consumption and irrigation purpose is difficult prolonged draught or during dry sunny periods. • It was also mentioned that wheat can be able to withstand the impact of frost therefore they will also vote for wheat. • SP is an important staple for both animal and human therefore, farmers mentioned that water and SP will be the first two important interventions to vote followed by wheat.