CHAPTER 5
RESULTS

This chapter provides the detailed results given by the previously discussed methods. It is divided into five parts, which are following closely the outline of the questionnaires distributed among app-users and non-users (see Appendix 11 & 12). The statistical results from the surveys are then cross-checked with the results after propensity score matching and either backed by the findings from the in-depth interviews or weakened by contrasting views.

5.1 Demographics

The study covered a total number of 150 participants where 50 were using the application while 100 farmers did not and acted as a control group. The average age of the participants was 50.51 years, although there are significant differences between both groups. In general, app users are younger than non-users (see Figure 15). The average age of users of the Farmer Info application is 42.98 years and thereby almost twelve years below the mean of non-users (54.27 years).

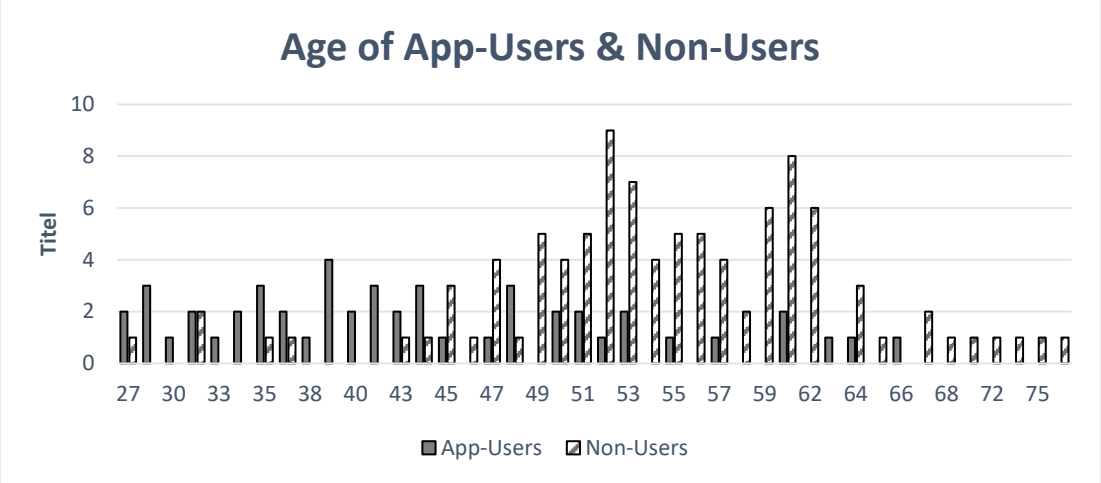

Figure 15 Age of App Users & Non-Users
Source: Own illustration

Regarding education and gender, the differences are less severe. Both groups consist mainly of male farmers with an educational level equal to primary school (see Figure 16). However, the data shows a slightly higher number of female farmers among the app users as well as a small number of higher educated.

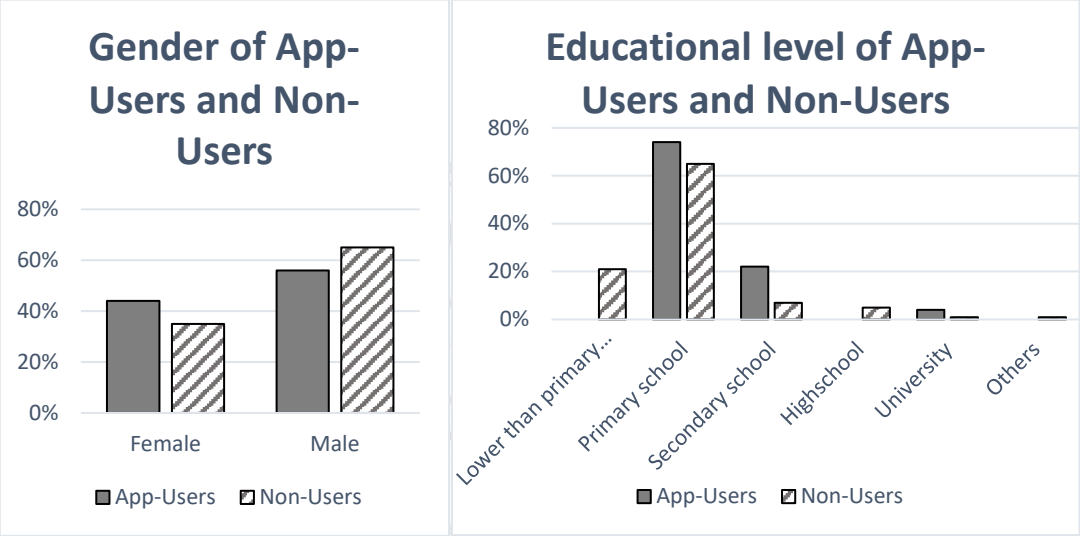

Figure 16 Gender and Educational Level of App-Users and Non-Users
Source: Own illustration

Similar findings can be observed regarding the martial status, the household size, the membership in a cooperation, the land status as well as the farm size.

The average farm size of the application users was 10.79 rai, with a maximum of 30 and a minimum of one rai. Non-users, on the other hand, have an average farm size of 11.66 rai (max. 40 rai, min. 2 rai). The average farm size can be translated into 1.6 – 2.0 hectare and is characteristic for small-scale farms. The yield differs significantly between both farmer groups and their main crops. For Longan the average yield per season is around 6 tons among farmers who are not using the application, while it is 30 tons for app-users. For rice the yield per season is close to 5 tons for non-users and more than double for farmers who are using the application (see Figure 17).

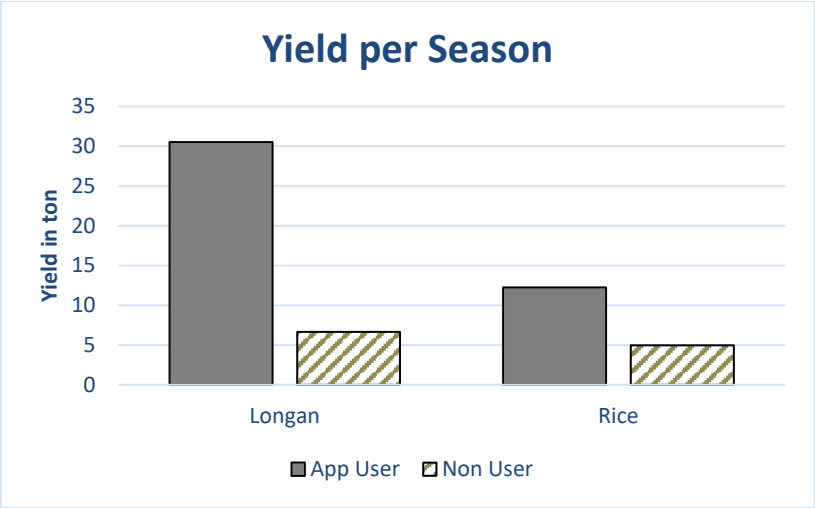

Figure 17 Average Yield per Season for Longan and Rice

Source: Own Illustration

When asked about their agricultural products, besides the main crops rice or longan, both groups showed a diverse production, where vegetables and fruits are dominating among non-users and fruits and grains among app-users (see Figure 18). The findings of the survey were also reflected in one in-depth interview with a farmer, who grew rice as the main crop but additionally planted fruits and vegetables in combination with aquaculture close to the rice fields (see Appendix 7).

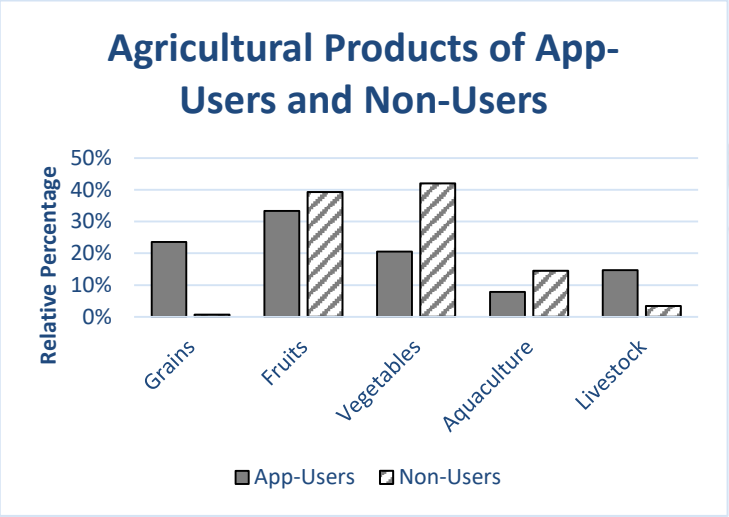

Figure 18 Agricultural Products of App-Users and Non-Users

Source: Own illustration

While both groups are diversified in their agricultural production, there were also differences between their marketing channels. On the one hand, app-users only used local village markets and middleman to sell their products, on the contrary, non-users used different channels, although village markets and intermediaries were still dominating (see Figure 19). Also, the two interviewed farmers, who used the Farmer Info application, were mainly marketing their products via the local markets. The interviewed farmer who was not using the application, however, was exporting his products and using a messenger application to market his produce.

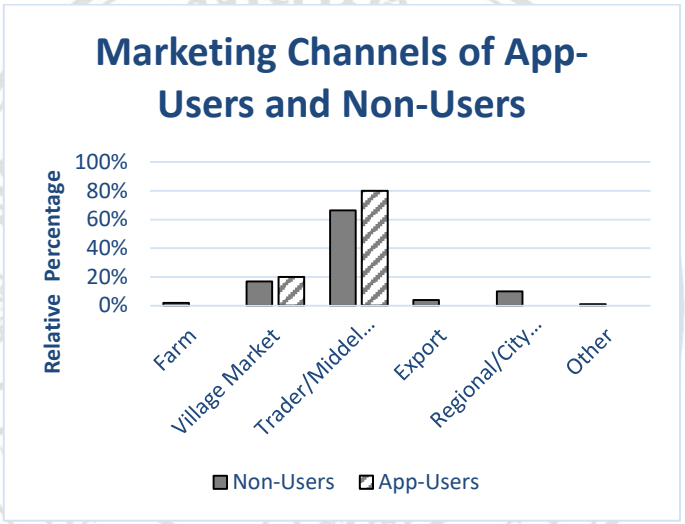

Figure 19 Marketing Channels of App-Users and Non-Users
Source: Own illustration

5.2 Farmer's Agricultural Problems and Needs

Besides the demographical indicators, the survey and interviews tried to cover agricultural aspects of the farmers. Therefore farmers were asked among others about the problems they are facing during a season.

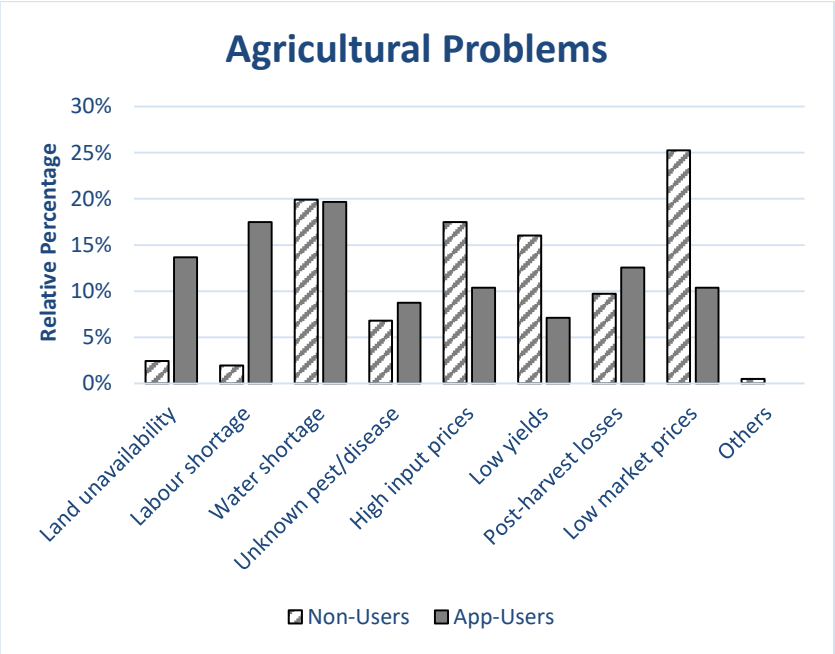

Figure 20 Agricultural problems of App-User and Non-Users
Source: Own illustration

When asked about the agricultural problems, non-users referred mostly to "Low market prices" as the main issue with over 25% of all answer referring to this category, followed by "Water shortage" and "High input prices". The users of the application, on the other hand, saw the biggest problem in "Water shortage", "Labour shortage" and "Land unavailability", respectively. In-depth interviews with farmers and Rawat Sangchuay (see Appendix) confirm the problems with water during the time of the data collection, as Thailand was at this point suffering from a drought. However, one of the farmers also specifically mentioned poor irrigation as a main reason for seasonal water shortages. Additionally, this farmer confirmed problems with labour as the younger generation moves out of the agricultural sector and prefers the urban area (see Appendix 7). Other issues brought up during the expert interviews included problems with pests and diseases and price fluctuation.

Furthermore, farmers were asked about the information they see as most important for their agricultural work. Farmers not using the application reported that "Market price" was the most crucial information for them, which is one line with the problem of low market prices. App-users on the other side indicate that information on "Pests and

diseases" is the most important. This finding was confirmed by two farmers who were interviewed in-depth.

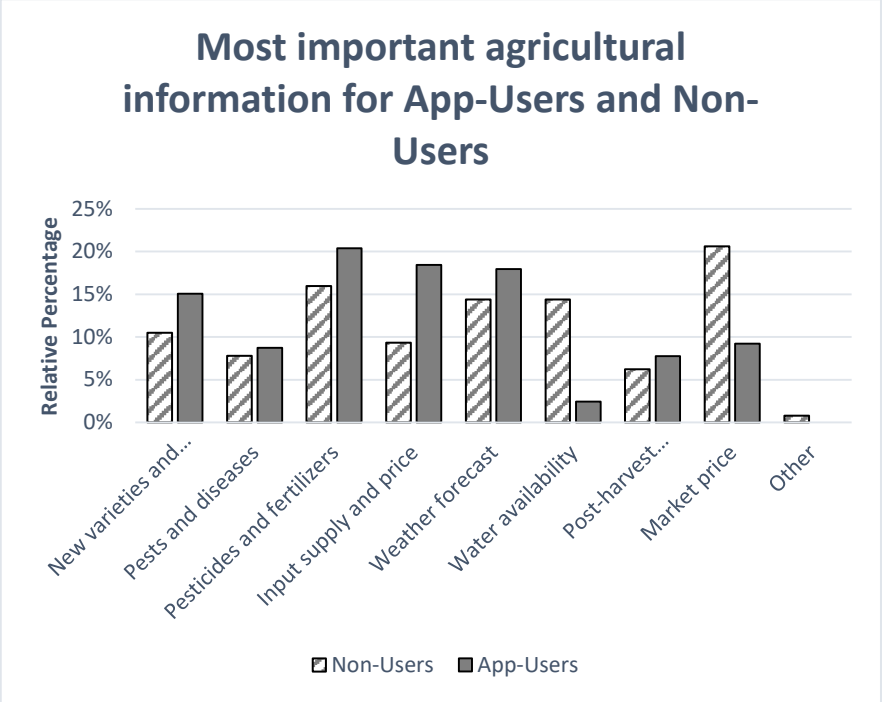

Figure 21 Most Important Information for App-Users and Non-Users
Source: Own illustration

Another question in the survey referred to the interest of the different farmers. In general, farmers using the application were more likely to be interested in new topics than non-users. Over 80% of the app-users were interested in information about new or different crops and breeds. Furthermore, the impact of pesticides and fertilisers on their health, general agricultural education and end-consumers' needs, as well as opinions, were high with over 70% of app-users interested (see Figure 22). In contrast, market access and marketing strategies were the top interest for non-users, although only slightly more than 40% of the participants indicated their interest. Overall non-users show a lower interest in new information or knowledge.

An important aspect regarding agricultural knowledge and information, which was constantly brought up during the interviews, was the exchange and sharing of ideas and know-how between farmers. All farmers referred at least once to the exchange of knowledge with other farmers through direct contact or group meetings. Thereby the

sharing of expertise included pest and disease management, cultivation and marketing.

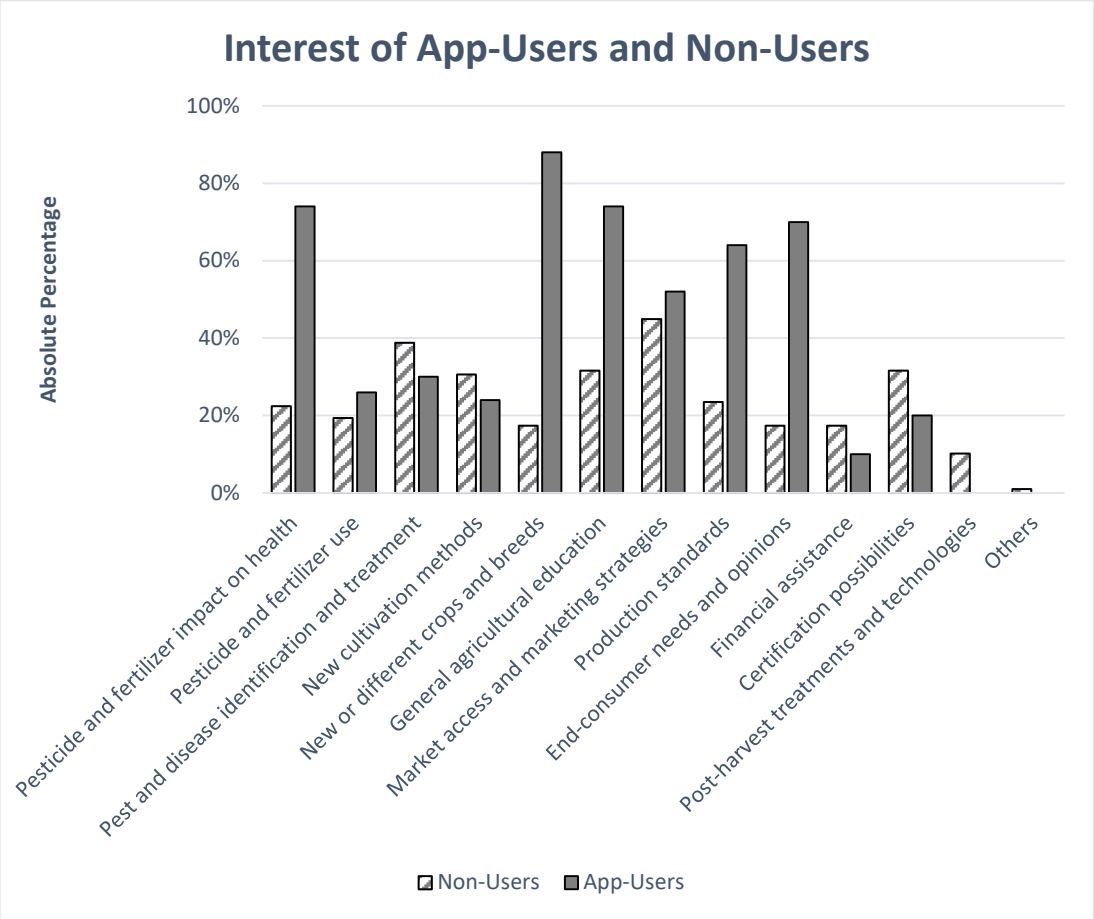

Figure 22 Interest of App-Users and Non-Users

Source: Own illustration

5.3 Mobile Phone Use of Farmers

An important aspect of analysing the impact of the Farmer Info application was to understand the attitude of farmers towards mobile phones and smartphones in general. Therefore several questions in the survey and during the in-depth interviews were focusing on the experience and opinion of farmers towards mobile devices. Additionally, the interviews with experts from dtac and RBK provided a deeper insight regarding farmers' attitudes towards mobile phones and their features.

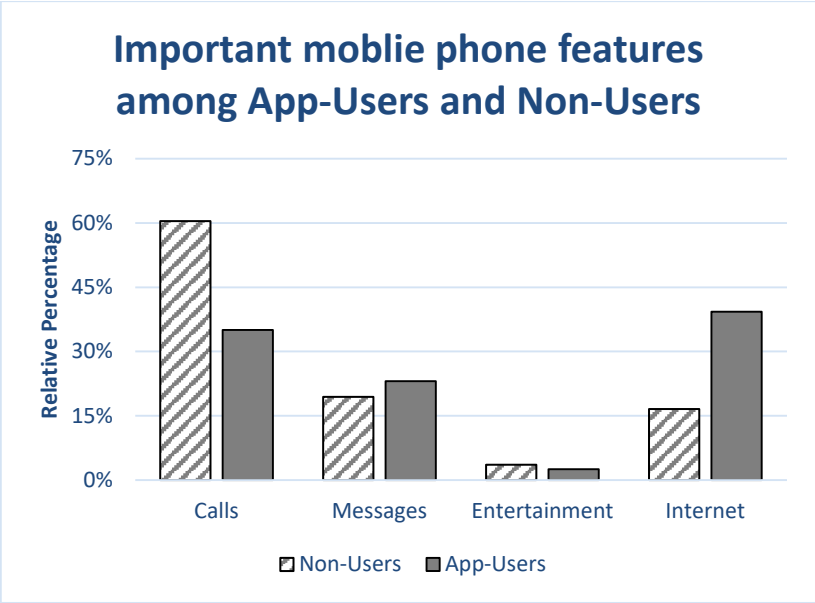

Figure 23 Most Important Mobile Features for App-Users and Non-Users

Source: Own illustration

When asked about the most important feature of a mobile device, the two surveyed groups focused on two different features. Among the application users the internet was the most important feature, followed by the call function (see Figure 23). Non-users clearly stated that the call function was the most important function, given to the fact that around 76% only used basic phones (see Figure 24).

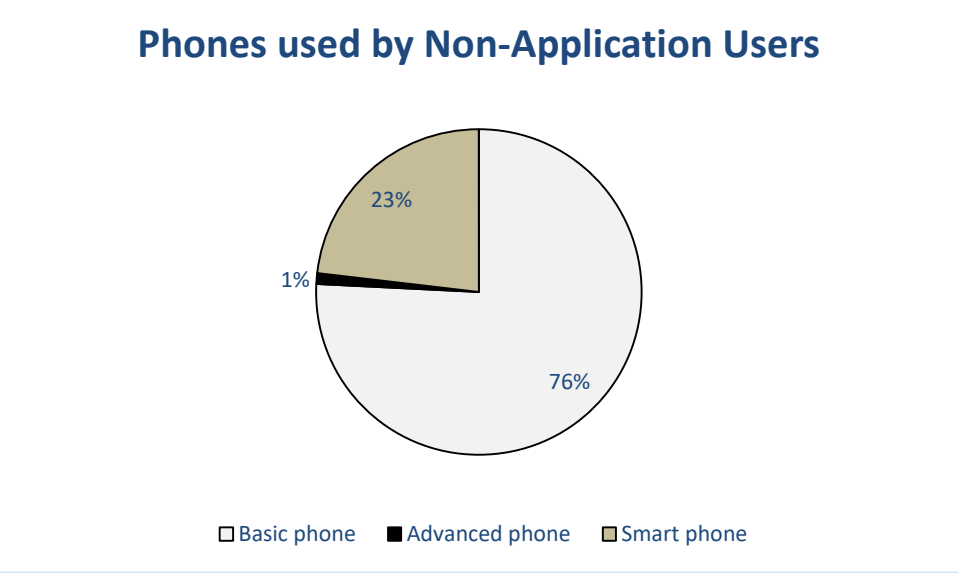

Figure 24 Phones Used by Non-Application Users

Source: Own illustration

Regarding the usefulness of mobile devices for their private life and agricultural work, the majority of farmers in both groups referred to cell phones as useful, and only a minority of non-users sees them at useless (see Table 7).

Table 7 Usefulness of Mobile Devices

		Very Useful	Useful	Neutral	Useless	Very useless
Usefulness for private life	**App-Users**	0.0%	54.0 %	46.0%	0.0%	0.0%
	Non-Users	14.0 %	46.0 %	32.0%	0.0%	1.0%
Usefulness for agricultural work	**App-Users**	16.0 %	62.0 %	22.0%	0.0%	0.0%
	Non-Users	12.0 %	46.0 %	31.0%	1.0%	2.0%

Source: Own calculation

Another important aspect in understanding the potential of mobile phones for agriculture is the farmers' opinion on how easy it is to learn and use such a device (see Table 8).

Table 8 Ease to Use for Mobile Devices

		Very Easy	Easy	Neutral	Difficult	Very Difficult
Ease to use	**App-Users**	44.0%	40.0%	16.0%	0.0%	0.0%
	Non-Users	2.0%	49.0%	40.0%	2.0%	0.0%
Ease to learn	**App-Users**	16.0%	62.0%	22.0%	0.0%	0.0%
	Non-Users	1.0%	24.0%	66.0%	1.0%	1.0%

Source: Own calculation

The majority of app-users thinks that mobile devices are very easy to use and it is easy to learn how to use them. Non-users indicate that it is easy to use mobile phones but have a neutral opinion on how easy or difficult it is to learn using cell phones. When farmers were asked the same question during the in-depth interviews all referred to smartphones as easy to use. However, it was also pointed out that they had problems at the beginning learning how to use them. Two farmers stated that their children were a huge help learning how to use the devices. Once they have learnt how to use their

smartphones, all three farmers used them daily, up to four hours, and considered them helpful. The majority of the survey participants used the different features provided by mobile devices between 1-30 minutes per day (see Table 9). Thereby non-users are mainly using the call and messaging functions, while app-users refer to a larger variety of functions provided by mobile devices.

Table 9 Mobile Usage of App-Users and Non-Users

		0 minutes	1-15 minutes	16-30 minutes	31-45 minutes	46-60 minutes	over 60 minutes	No Response
Calls	**App-Users**	0.0%	72.0%	28.0%	0.0%	0.0%	0.0%	0.0%
	Non-Users	1.0%	87.0%	4.0%	0.0%	0.0%	4.0%	4.0%
Messages	**App-Users**	0.0%	52.0%	48.0%	0.0%	0.0%	0.0%	0.0%
	Non-Users	72.0%	16.0%	6.0%	1.0%	0.0%	1.0%	4.0%
Music	**App-Users**	16.0%	26.0%	58.0%	0.0%	0.0%	0.0%	0.0%
	Non-Users	83.0%	3.0%	9.0%	1.0%	0.0%	0.0%	4,0%
Game	**App-Users**	28.0%	56.0%	16.0%	0.0%	0.0%	0.0%	0.0%
	Non-Users	83.0%	2.0%	7.0%	0.0%	3.0%	1.0%	4.0%
Video	**App-Users**	4.0%	62.0%	34.0%	0.0%	0.0%	0.0%	0,0%
	Non-Users	83.0%	2.0%	7.0%	0.0%	3.0%	1.0%	4.0%
Internet	**App-Users**	0.0%	72.0%	22.0%	6.0%	0,0%	0.0%	0.0%
	Non-Users	77.0%	2.0%	7.0%	3.0%	5.0%	2.0%	4.0%
Other	**App-Users**	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Non-Users	96.0%	0.0%	0.0%	0,0%	0.0%	0.0%	4.0%

Source: Own calculation

5.4 Farmer Info Application

Interviews with the major stakeholders from dtac and RBK revealed that the Farmer Info application is a crucial part of RBK's strategy to improve the situation of Farmers in Thailand. Besides the application, the services of Rak Ban Kerd cover the distribution of information through SMS, a call centre as well as a website. Dtac furthermore promotes the development of Smart Farmers and most recently focusing on Young Farmers. During the first interview with an official from RBK, it was pointed out that the SMS-service was the logical consequence of a growing number of mobile phones among farmers. As a result, over 1000 farmers were called for a meeting to identify their needs. According to the RBK official, the only goal which all farmers had in common was a better way of life. Therefore, RBK started the SMS-service in 2003 distributing

price information. The only duty of the farmer, according to RBK, is to use this information to compare prices which will result in a better way of life.

The application was then consequently a result of a growing number of smartphone users in Thailand. Additionally to the collection of agricultural prices, more features were added in the application. However, the price checking tool was still seen as the most important during the interviews with RBK. When farmers were asked in the survey what they consider to be the most important feature, they confirmed it (see Figure 25). The in-depth interviews with the farmers, on the other hand, showed that the feature to compare prices is seen less important. For the two interviewed app-users the video function is the best part of the application. According to them, it provides helpful agricultural information on a variety of subjects. The price tool, however, was criticised not covering sufficient markets, which makes price comparing more difficult.

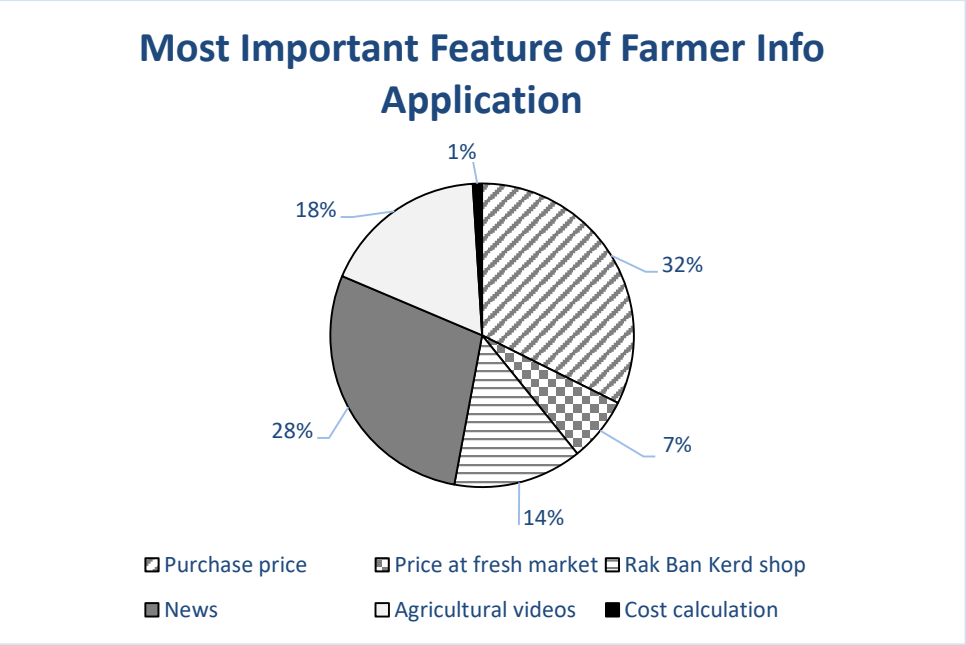

Figure 25 Most important feature of Farmer Info application

Source: Own illustration

Furthermore, non-users were asked what they would expect from an agricultural application for mobile phones. Almost one-third of the farmers stated that better marketing would be the most desirable outcome from such a service, followed by lower production costs and lower input prices. Contrary to the statement of the Rak Ban Kerd official a higher income was ranked fifth (see Figure 26).

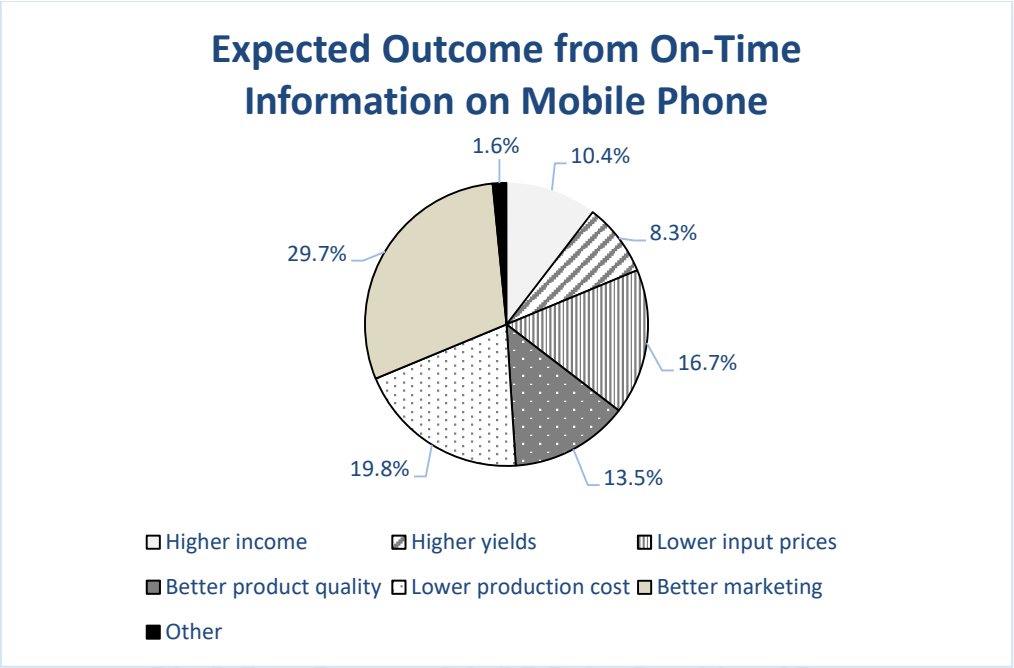

Figure 26 Expected Outcomes from Mobile Application by Non-Users
Source: Own illustration

5.4.1 Impact on Livelihood

Following the main goal of Rak Ban Kerd, the application should enable farmers to compare prices between markets resulting in a better income and higher overall selling prices. Therefore certain variables were used as indicators for the livelihood situation of Thai farmers (see Table 10 & 11).

Table 10 Key Variables for Livelihood Impact Analysis (Longan Farmers)

	N[a]	Min.[a]	Max.[a]	Mean[a]	Std. Dev.[a]	N[b]	Min.[b]	Max.[b]	Mean[b]	Std. Dev.[b]
Average monthly income from agriculture	50	3000	25000	7911.66	5088.569	25	15000	30000	21240,00	4806.939
Average monthly income from other activities	50	0	12000	2582.00	3247.774	25	0	5000	1440,00	1325.393
Average Price (Baht per kilo)	49	10.00	36.00	21.9082	4.91349	25	20.00	35,00	26.6800	4.48813
Highest Price (Baht per kilo)	40	15.00	36.00	24.2500	4.89767	25	30.00	45,00	36.3600	5.42279
Lowest Price (Baht per kilo)	40	4.00	20.00	11.8000	4.66960	25	15.00	25,00	19.2000	3.04138

a. Non-Users, Longan Farmers

b. App-Users, Longan Farmers

Source: Own Calculation

Table 11 Key Variables for Livelihood Impact Analysis (Rice Farmers)

	N[a]	Min.[a]	Max.[a]	Mean[a]	Std. Dev.[a]	N[b]	Min.[b]	Max.[b]	Mean[b]	Std. Dev.[b]
Average monthly income from agriculture	50	2000	40000	5280.00	6758.336	25	10000	27000	17800.00	4591.659
Average monthly income from other activities	50	0	30000	3810.00	6522.934	25	0	5000	2120.00	1542.995
Average Price (Baht per kilo)	49	5.50	17.00	11.2327	2.18855	25	7,50	11,00	8.7600	0.79215
Highest Price (Baht per kilo)	44	5.50	35.00	12.8409	4.47963	25	8,00	13,00	10.4200	1.03763
Lowest Price (Baht per kilo)	43	4.00	12.00	8.4651	2.04531	25	6,00	10,00	7.7520	1.11994

a. Non-Users, Rice Farmers

b. App-Users, Rice Farmers

Source: Own Calculation

A Mann-Whitney test was used for all livelihood variables to highlight differences between longan farmers who were using the application and farmers who did not use it (see Table 12 & 13).

Table 12 Mann-Whitney Test Ranks for Livelihood Variables (Longan Farmers)

User of Farmer Info App		N	Mean Rank	Sum of Ranks
Average monthly income from agriculture (Baht)	No	50	26.72	1336.00
	Yes	25	60.56	1514.00
	Total	75		
Average monthly income from other activities (Baht)	No	50	37.79	1889.50
	Yes	25	38.42	960.50
	Total	75		
Average price (Baht per kilo)	No	49	31.23	1530.50
	Yes	25	49.78	1244.50
	Total	74		
Highest price (Baht per kilo)	No	40	21.59	863.50
	Yes	25	51.26	1281.50
	Total	65		
Lowest price (Baht per kilo)	No	40	23.65	946.00
	Yes	25	47.96	1199.00
	Total	65		

a. Grouping Variable: User of Farmer Info App

Source: Own Calculation

Table 13 Mann-Whitney Test Statistics for Livelihood Variables (Longan Farmers)

	Average monthly income from agriculture (Baht)	Average monthly income from other activities (Baht)	Average price (Baht per kilo)	Highest price (Baht per kilo)	Lowest price (Baht per kilo)
Mann-Whitney U	61.000	614.500	305.500	43.500	126.000
Wilcoxon W	1336.000	1889.500	1530.500	863.500	946.000
Z	-6.367	-0.122	-3.592	-6.254	-5.180
Asymp. Sig. (2-tailed)	0.000	0.903	0.000	0.000	0.000

a. Grouping Variable: User of Farmer Info App

Source: Own Calculation

A Man-Whitney U test indicated that agricultural income for longan farmers who used the Farmer Info application was significantly higher (M[1] = 21240) than for longan farmers who did not use the application (M = 7911.66), U = 61, p = .000 (see Figure 27)[2]. The effect size was strong according to Cohen with r = 0.73. The results point out that farmers who use the Farmer Info application have a significantly higher income from agriculture than those who do not.

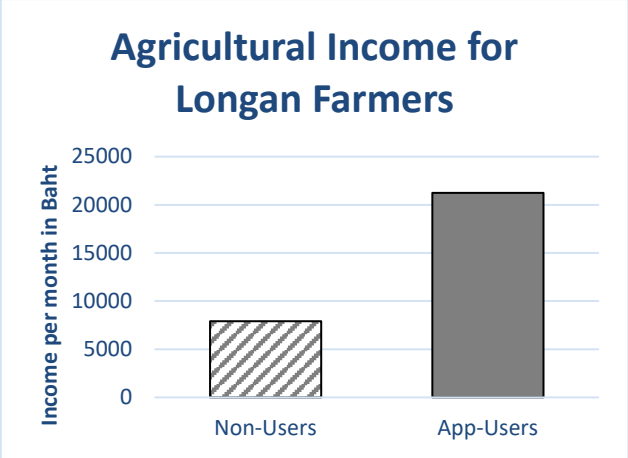

Figure 27 Average Agricultural Income for Longan Farmers
Source: Own illustration

The Mann-Whitney U Test, on the other hand, showed no significant difference for the average monthly income from other activities between app-users (M = 1440) and non-users (M = 2582), U = 614.5, p > .903.

For the average selling price the Mann-Whitney test indicates a significant difference between app-users (M = 26.68) and non-users (M = 21.91), U = 305.5, p < .000 with an average effect size of r = 0.41. Furthermore, the test shows significant differences between farmers, who use the application and farmers, who do not, regarding the highest and lowest price, which has ever been achieved (see Table 12 & 13). Thereby, the effect size for the highest and lowest price is strong with r = 0.77 and r = 0.64, respectively. It can be said that Farmer Info users have overall a higher selling price for

[1] "M" in this case stands for the mean of the analysed variable
[2] The average monthly income from agricultural activities in Thailand varies between 8999 and 15268 Baht per month depending on the main product and land tenure. The overall average income in Thailand is 26915 Baht per month while 19650 Baht are related to money income from work activities (National Statistical Office of Thailand 2015).

longan (see Figure 28)[3]. All the variables show similar significant results after matching, with minimal changes, including within the means (see Appendix 14).

Figure 28 Selling Prices for Longan among App-Users and Non-Users

Source: Own illustration

In a second Mann-Whitney U test the same livelihood variables, as analysed before, were evaluated for rice farmers who used the application and farmers who did not (see Table 14 & 15).

Table 14 Mann-Whitney Test Ranks for Livelihood Variables (Rice Farmers)

User of Farmer Info App		N	Mean Rank	Sum of Ranks
Average monthly income from agriculture (Baht)	No	50	26.69	1334.50
	Yes	25	60.62	1515.50
	Total	75		
Average monthly income from other activities (Baht)	No	50	38.49	1924.50
	Yes	25	37.02	925.50
	Total	75		
Average price (Baht per kilo)	No	49	46.71	2289.00
	Yes	25	19.44	486.00
	Total	74		
Highest price (Baht per kilo)	No	44	41.86	1842.00
	Yes	25	22.92	573.00
	Total	69		
Lowest price (Baht per kilo)	No	43	38.36	1649.50
	Yes	25	27.86	696.50
	Total	68		

Source: Own calculation

[3] The current price for longan (December 2016) is 36.9 Baht per kilogram. Data shows that over the last 15 years the lowest price recorded for longan was down to 9.1 Baht per kilogram (August 2002), while the highest price was 44.2 (June 2016/January 2014). The data also shows that over the years the average price for longan has increased (Bank of Thailand 2017)

Table 15 Mann-Whitney Test Statistics for Livelihood Variables (Rice Farmers)

	Average monthly income from agriculture (Baht)	Average monthly income from other activities (Baht)	Average price (Baht per kilo)	Highest price (Baht per kilo)	Lowest price (Baht per kilo)
Mann-Whitney U	59.500	600.500	161.000	248.000	371.500
Wilcoxon W	1334.500	925.500	486.000	573.000	696.500
Z	-6.411	-0.280	-5.214	-3.801	-2.133
Asymp. Sig. (2-tailed)	0.000	0.779	0.000	0.000	0.033

Source: Own calculation

Also for the rice farmers, the Mann-Whitney U test indicates a significant difference for the average agricultural income for app-user (M = 17800) and non-users (M = 5280), U = 59.5, p < .000 with a strong effect size of r = 0.74. Application users have an overall higher agricultural income than farmers who do not use the Farmer Info application (see Figure 29).

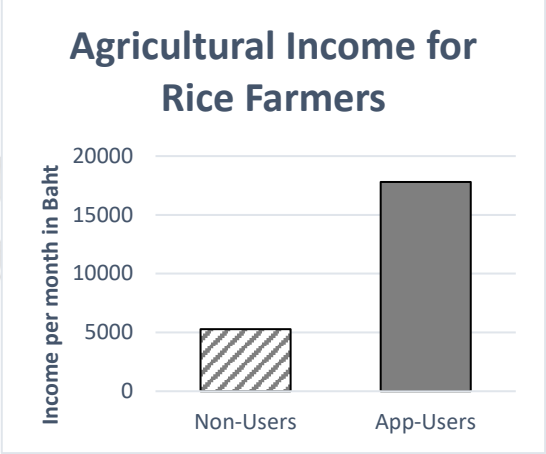

Figure 29 Average Agricultural Income for Rice Farmers

Source: Own illustration

Similar to the results for the longan farmers, there is no significant impact regarding the average income from other activities for farmers, who use the application (M = 3810) and farmers who do not (M = 2120), U = 600.5, p > .779.

However, the average selling price for rice shows significant difference between app-users (M = 8.76) and non-user (M = 11.23), U = 161, p < .000 with a strong effect size of r = 0.61. Also the price difference for the highest and lowest price, ever achieved, is significant between farmers who use the application and farmers who do not (compare Table 14 & 15). The effect size for the highest and lowest price thereby is average (r = 0.46) and low (r = 0.25), respectively. Conclusively, prices are overall higher among rice farmers, who are not using the application than farmers who do[4].

After matching and dealing with missing data, the Mann-Whitney U test provides almost identical results for all variables, with minimal differences for both groups, except for "Lowest Price". In this case, the result, after matching and eliminating all cases containing missing data, shows no significant difference between app-users (M = 7.75) and non-users (M = 8.24), U = 384, p > .165 (see Appendix 14).

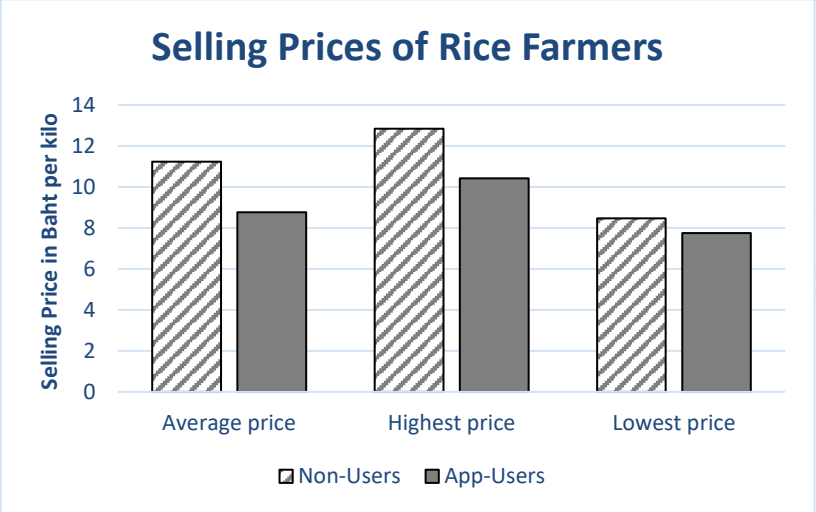

Figure 30 Selling Prices for Rice Farmers

Source: Own illustration

[4] The current price for rice varies between 7449 Baht per metric ton and 11967 Baht depending on the rice. Therefore per kilo prices vary between 7.449 and 11.967 Baht (December 2016). Depending on the rice variety, rice prices reached up to 14.8 Baht per kilo (Glutinous rice, November 2013), but also dropped to 4.322 Baht per kilo (Second rice, Auguste 2002). Overall, similar to longan, prices have increased over the last 15 years with low fluctuation in recent years (Bank of Thailand 2017).

Following the in-depth interviews, these results are in line with the goals of Rak Ban Kerd regarding all variables of the longan farmers and the average agricultural income of the rice farmers. However, the selling prices for rice farmers are not following the proposed goal of achieving higher prices for app-users through price comparison. In general, the interviews with farmers indicated that the price comparing tool of the application seems less useful than other tools, mainly due to poor market coverage in the area of Chiang Rai Province. As a result, the interviewed farmers mainly did not use the price comparing tool or were not interested in it, whereas it is unlikely they were able to get higher sale prices through comparison.

5.4.2 Impact on Pesticide Use

Apart from raising farmers' income, Rak Ban Kerd and dtac promote more sustainable and organic agriculture. The application, therefore, provides news and videos for the peasants, where they can learn new agricultural practices. In this context, the pesticide and fertiliser use of farmers in Thailand was analysed. The key variables of this impact analysis are summarised in Table 16.

Table 16 Key Variables for Practice Impact Analysis

	N[a]	Min.[a]	Max.[a]	Mean[a]	Std. Dev.[a]	N[b]	Min.[b]	Max.[b]	Mean[b]	Std. Dev.[b]
Pesticides used	99	1	4	1.90	1.035	50	1	4	2.98	1.020
Pesticide application per month	97	0	3	0.95	0.512	50	0	2	0.58	0.609
Monthly spending on pesticide	99	0	10000	1196.92	1306.705	50	0	1000	36.00	161.321
Fertilizers used	100	1	4	2.14	0.964	50	1	4	2.84	1.167
Fertilizer application per week	97	0	3	1.04	0.417	50	0	1	0.52	0.505
Monthly spending on fertilizer	98	0	9000	1918.11	1735.842	50	0	4000	460.00	1265.072

a. Non-Users

b. App-Users

Source: Own Calculation

A Mann-Whitney U Test was conducted for all metric variables within the set of variables representing the use of pesticides and fertilisers.

Table 17 Mann-Whitney Test Ranks for Pesticide Use

User of Farmer Info App		N	Mean Rank	Sum of Ranks
Pesticide application per week	No	97	82.57	8009.00
	Yes	50	57.38	2869.00
	Total	147		
Monthly spending on pesticide	No	99	96.83	9586.00
	Yes	50	31.78	1589.00
	Total	149		
Fertilizer application per month	No	97	85.76	8319.00
	Yes	50	51.18	2559.00
	Total	147		
Monthly spending on fertiliser	No	98	93.13	9127.00
	Yes	50	37.98	1899.00
	Total	148		

Source: Own calculation

Table 18 Mann-Whitney Test Statistics for Input Use

	Pesticide application per week	Monthly spending on pesticide	Fertilizer application per month	Monthly spending on fertiliser
Mann-Whitney U	1594.000	314.000	1284.000	624.000
Wilcoxon W	2869.000	1589.000	2559.000	1899.000
Z	-4.166	-8.964	-5.931	-7.573
Asymp. Sig. (2-tailed)	0.000	0.000	0.000	0.000

a. Grouping Variable: User of Farmer Info Application

Source: Own Calculation

The Mann-Whitney U Test for the monthly spending on pesticides indicates that it is significantly lower among app users (M = 36) than among non-users (M = 1196.92), U = 314, p < .000 (see Figure 31), with a strong effect size of r = 0.73[5]. The test also shows that app-users apply pesticides less frequently per week (M = 0.58) than non-users (M = 0.95), U = 1594, p < .000 (see Figure 31), with an average effect size of r = 0.34[6].

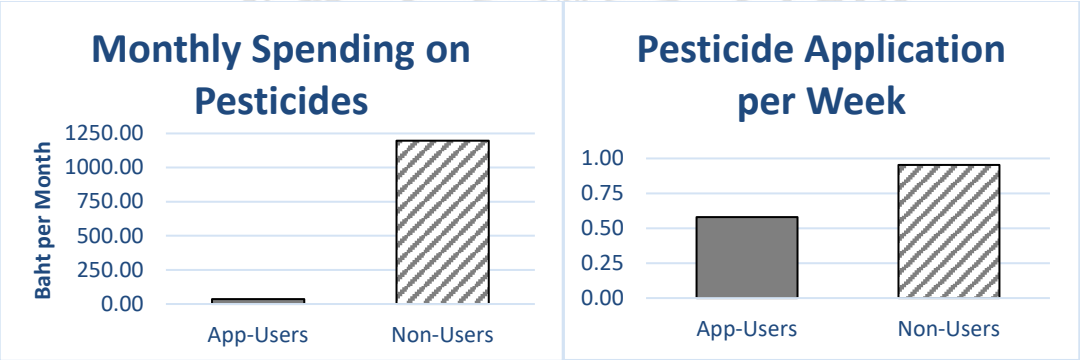

Figure 31 Monthly Spending on & Weekly Applications of Pesticides by App-Users and Non-Users

Source: Own illustration

Also for the monthly spending on fertilizer the Mann-Whitney U test shows a significant lower amount for app-users (M = 460) than for non-users (M = 1918.11), U = 624, p < .000 (see Figure 32), with a strong effect size of r = 0.62[7]. Farmers using the application also apply fertilisers less often per month (M = 0.52) than farmers, who are

[5] According to Riwthong et al. (2015) pesticides in upland agriculture take up around 13% of the total input costs in Thailand. The total average input costs (combining variable and fixed costs) is thereby estimated to be 638 USD/ha (~ 3,569 Baht/rai). A calculation for rice farmers was done by Arayaphong (2012) who estimated that the costs for pesticides under a conventional system equals 295.04 USD/ha/year (~ 1,650.56 Baht/rai/year = 137.55 Baht/rai/month). Schreinemachers et al. (2011) showed that rice farmers spend around 100 Baht/ha/month. Furthermore, they showed that litchi farmers also only spend around 200 Baht/ha/month.

[6] Riwthong et al. (2015) identified that in average farmers apply pesticides seven times a year in Thailand. However, when analysing different groups, they found out that people in the low use category only apply pesticides twice a year compared to sixteen times in the high use category. In average farmers are thereby applying 9 kg/ha/year (1.44 kg/rai/year). However high users are applying up to 22 kg/ha/year while low users only 1.4 kg/ha/year in average. Schreinemachers et al. (2011) showed that rice farmers only apply around 0.1 kg/ha/month of active ingredients and litchi farmer 0.8 kg/ha/month.

[7] The average total cost for fertilizer in rice production varies between 56,696 and 42,004 Baht/ha (~ 9,071 – 6,720 Baht/rai) for rain-fed and irrigated cultivation, respectively (Liese et al. 2014). For longan no data regarding the average costs for fertilizer is available. Also there are no records regarding the overall fertilizer costs or the percentage of input costs per farm or hectare in Thai agriculture.

not using the application (M = 1.04), U = 1284, p < .000 (see Figure 32)[8]. Also with an average effect size of r = 0.49. All results are also significant after matching is performed, with slight changes regarding the means between the groups (see Appendix 14).

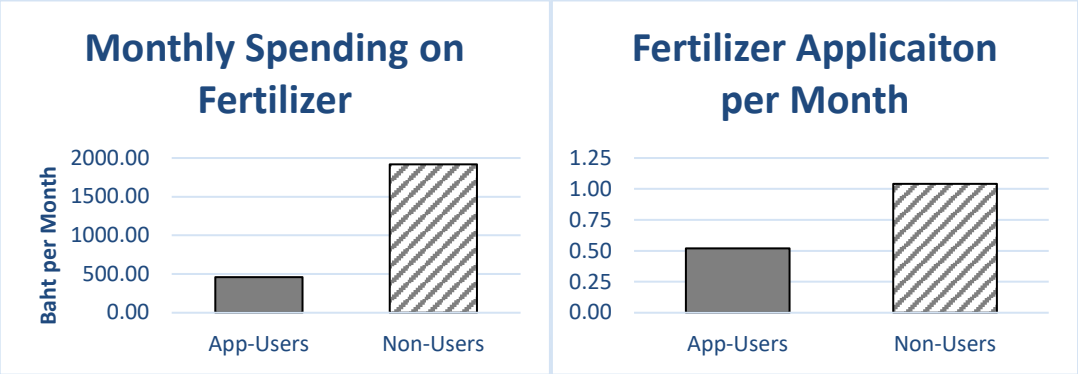

Figure 32 Monthly Spending on & Weekly Applications of Fertilisers by App-Users and Non-Users

Source: Own illustration

Besides the frequency of pesticide or fertiliser application and the monthly amount spent, the type of pesticide and fertiliser used by farmers was also of interest.

[8] For rice it is recommended to apply fertilizer around two to three times per growing season. Thereby phosphorus (P) and potassium (K) are applied just before seeding while nitrogen (N) is used two to three times after seeding. Nitrogen is often the most limiting factor for rice and it is recommended to apply 15-20 kg/ton (International Rice Research Institute 2012). For Longan the average fertilizer application is recommended to be three to four times a year with 15-20 kg/tree when the trees are in an immature stage. For mature trees it is recommended to apply fertilizer approximately four times per cropping cycle totalling an amount of 10-15 kg/tree. Thereby the main fertilizer used is NPK, however, calcium nitrate can be added as supplement (Food and Agriculture Organization of the United Nations 2000). According to Riwthong et al. (2015) the use of mineral fertilizer in Thailand can vary between 17 kg/ha up to 414 kg/ha whereas the average application is about 178 kg/ha (~ 28.48 kg/rai).

Table 19 Crosstab Pesticides Used/Fertilizers Used*User of Farmer Info Application

	Fertilizers used			Pesticides used		
	User of Farmer Info App		Total	User of Farmer Info App		Total
	No	Yes		No	Yes	
Chemical	39	6	45	55	1	56
Organic	9	20	29	2	23	25
Both	51	0	51	39	2	41
Other	1	24	25	3	24	27
Total	100	50	150	99	50	149

Source: Own Calculation

Table 20 Chi-Square Tests for Pesticides & Fertilizers Used

	Value	df	Asymptotic Significance (2-sided)[a]	Value	df	Asymptotic Significance (2-sided)[b]
Pearson Chi-Square	94.349[c]	3	0.000	115.850[d]	3	0.000
Likelihood Ratio	111.293	3	0.000	131.349	3	0.000
Linear-by-Linear Association	13.899	1	0.000	29.496	1	0.000
N of Valid Cases	150			149		

a. Fertilizers Used

b. Pesticides Used

c. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.33.

d. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.39.

Source: Own Calculation

Table 21 Symmetric Measures for Pesticides & Fertilizers Used

		Value	Approximate Significance[a]	Value	Approximate Significance[b]
Nominal by Nominal	Phi	0.793	0.000	0.882	0.000
	Cramer's V	0.793	0.000	0.882	0.000
	Contingency Coefficient	0.621	0.000	0.661	0.000
N of Valid Cases		150		149	

a. Fertilizers Used

b. Pesticides Used

Source: Own Calculation

The Chi-Square test shows that the type of fertiliser used and the use of the Farmer Info application are correlated ($\chi^2(3) = 94.349$, $p < .000$, $n = 150$). Thereby the association is strong as indicated by Cramer's V (CV = .793, $p < .000$) and the Contingency Coefficient (CC = .621, $p < .000$). Figure 31 shows that non-users are mainly using chemical fertilizers or a combination between chemical and organic, while organic or other fertilizers are dominating within the group of application users.

Similar findings can be found regarding the type of pesticides the farmers use. The Chi-Square test shows that there is a correlation between the pesticides used by the farmers and the use of the Farmer Info application ($\chi^2(3) = 115.85$, $p < .000$, $n = 149$). Following the symmetric measures by Cramer's V (CV = .882) and the Contingency Coefficient (CC = .661) the correlation can be categorized as strong. Non-users are thereby using more chemical pesticides or a combination with organic, while farmers, who are using the application, are more prone to organic pesticides or other forms (see Figure 33)[9]. Similar results are observed when matching is used (see Appendix 14). All results show a significant impact of the application on the type of pesticides or fertilisers used.

[9] The agricultural census of 2013 for Thailand shows that 92.3 percent of famers in Thailand are using fertilizer. Out of them 51.5% use mainly inorganic fertilizer while only 2.4% use organic and 1.8% bio fertilizer. However, 34.7% are using a combination of inorganic fertilizer with other fertilizers. For the use of pesticides the census shows that only 45.1% use pesticides at all while 54.9% do not. The main share of the farmers thereby use chemical pesticides (42.1%) and only a small share of 4.9% refers to organic pesticides (National Statistical Office of Thailand 2013). Numerous of the chemicals used in agricultural are thereby categorized as extremely or highly hazardous. Also the use of banned chemicals in Thailand is a persistent problem over the last years.

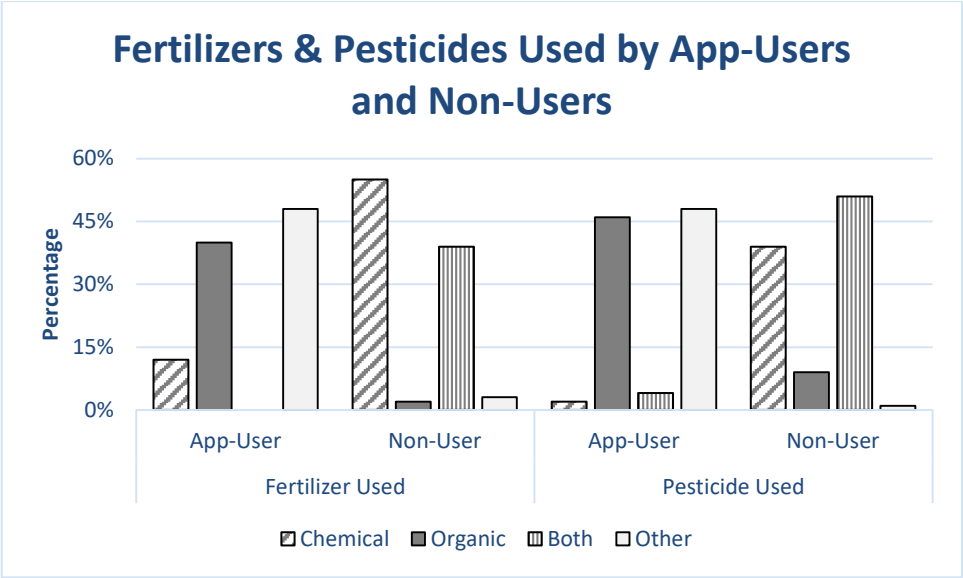

Figure 33 Fertilisers & Pesticides Used by App-Users and Non-Users

Source: Own illustration

5.5 Farmer Info Satisfaction and Future Development

It is not sufficient to just analyse the impact of a smartphone application, but it is also necessary to point out the level of satisfaction. Figure 34 illustrates that over 70% of the survey participants were satisfied with the application, while only 12% had a neutral opinion. No participant stated a low level of satisfaction. These findings are confirmed by the two farmers interviewed, who use the application.

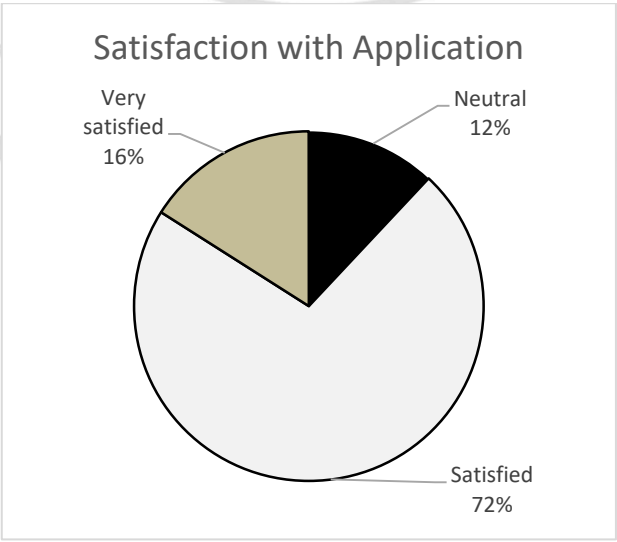

Figure 34 Level of Satisfaction

Source: Own illustration

The overall positive feedback is also backed up through social media channels, where the majority of people points out the benefits of the application and appreciates the commitment of dtac and Rak Ban Kerd. However, there is also criticism. One of the biggest concerns online, which was mentioned several times, was the limitation of the service to dtac customers only. More detailed a critic referred to the application as a simple corporate social responsibility strategy of dtac to improve their image (see Appendix 9). Although it was pointed out in the interviews with experts from Rak Ban Kerd and dtac that the information is freely available to everyone on the website, in the same interviews it was described how the application and other services are used to attract new customers.

When asked about the trustworthiness of information provided by dtac or RBK, farmers, who were not using the application yet, mainly referred to both as not trustworthy. However, Rak Ban Kerd Foundation was still seen as more trustworthy than dtac as a mobile phone provider (see Figure 35). Overall most farmers think that agricultural information should be provided by the Thai Ministry of Agriculture and Cooperation (80.9%), followed the Ministry of Information and Technology (9%), Universities (6.7%) and last a mobile phone provider (3.4%).

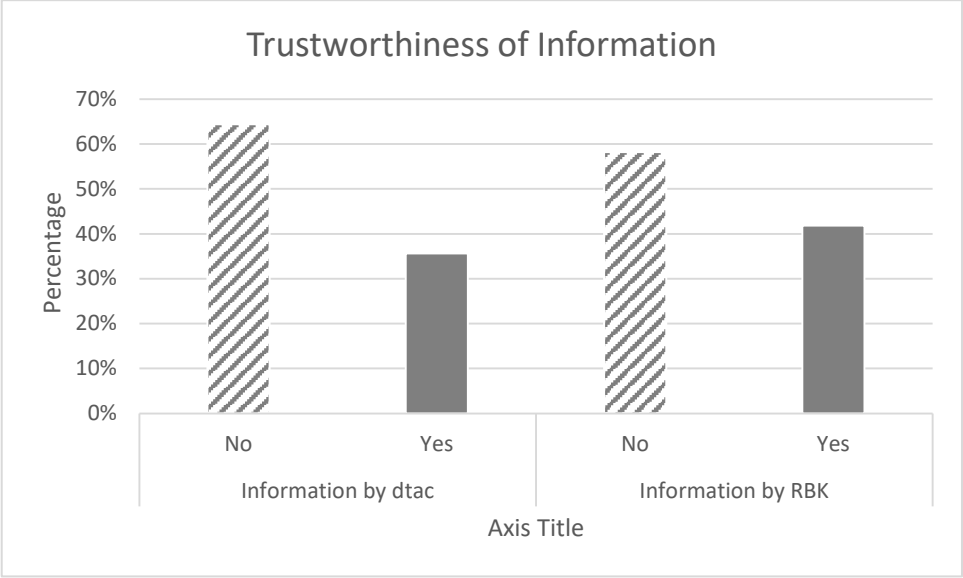

Figure 35 Trustworthiness of Information Providers

Source: Own illustration

Criticism about the application was also brought up by experts from dtac, who highlighted the poor management of the application by Rak Ban Kerd Foundation. First, it was pointed out by them that the e-commerce was too complex for farmers, who just started to use mobile devices and the internet to market their products. Secondly, the overall development and technological performance of RBK was criticised, including the market coverage. However, although dtac is the main sponsor of the services, they have no direct influence and can only provide suggestions to Rak Ban Kerd Foundation.

The need for further development of the Farmer Info application has already been recognised by Rak Ban Kerd officials, who discussed various options during the interviews. The ideas included the improvement of the e-commerce website (which at this point has already been done), the integration of more information, such as weather data, while simplifying the application. Furthermore, the re-branding of the application was highly discussed, as the term “Farmer Info” seemed confusing for Thai farmers, who mainly do not speak English. Overall the application should become more user-friendly.

When survey participants were asked about the need for additional information, they unanimous stated that no new data is required. This was confirmed by the interviewed farmers, who used the application. However, they stated that the application should be promoted stronger among the community. Additionally, the market coverage should be increased, and information should be published more frequently to provide farmers with more knowledge.